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Conducted by MAJOR B. BADEN-POWELL, F.R.A.S., F.R.Met.S., and E. S. GREW, M.A.

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Whales and Dolphins in the British Museum.*

ONE of the most wonderful exhibits in the Natural History branch of the British Museum is the series of models, skeletons, skulls, and stuffed skins of whales, dolphins, and porpoises arranged in the temporary annexe to the bird gallery, known as the whale-room. Indeed, at the time this exhibition was prepared and installed under the immediate direction of Sir William Flower, it was unique of its kind, although we believe that attempts have of late years been made to rival it in some foreign museums. Hitherto there have been no special guide-books to this section of the museum; all the information that the general public could acquire in regard to it being contained in the guide to mammals generally and in the descriptive labels in the whale-room itself. We are therefore glad to welcome the excellent little guide-book now before us, which is just what such a work should be, and is rendered specially attractive by the numerous photographic and other illustrations, a few of which are here reproduced.

We are told in the preface that, owing to the amount of oil they contain, the skins of whales and dolphins are exceedingly difficult to prepare for museum exhibition; and it is for this reason, coupled with the practical impossibility of obtaining and handling complete skins of the larger members of the former group, that the museum exhibit consists mainly of skeletons and models. The idea of exhibiting half-models of the larger whales, mounted on one side of the actual skeletons, originated, we believe, with Sir W. H. Flower, and has proved to be in all respects thoroughly satisfactory. The one drawback to the exhibition is the relatively small size and lowness of the building, which does not admit of the huge bulk and form of the larger specimens being fully realised and appreciated.

The guide commences with a brief but sufficient account of the leading structural peculiarities of cetaceans, in the course of which reference is made to the function of the "blubber" in retaining the heat of the body, and to the peculiar mode of respiration. In connection with the latter point, it may be mentioned that whales were once supposed to descend to enormous depths in the ocean in the intervals between their periodical appearances at the surface. Recently, however, it has been pointed out that they would be quite unable to withstand the enormous pressure at such depths, and likewise that they could not see to capture the animals on which they feed, to say nothing of the absence of suitable creatures for food at these abyssal depths. The probability, therefore, is that whales descend only to a comparatively moderate depth, where they are able to use their small eyes with effect.

Very curious is it to reflect that whereas the Greenland right-whale and some of the rorquals subsist entirely on the minute pteropod molluscs and crustaceans which go to form the "plankton" of the ocean surface, the sperm-whale feeds on giant cuttle-fishes, from which it hacks off "chunks" of flesh measuring six feet or more in cube.

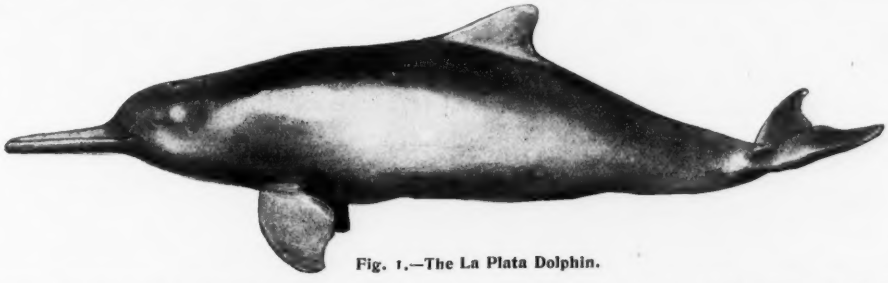

Fig. 1.—The La Plata Dolphin.

One problem connected with the physiology of whales is whether they sleep. If they do, they must sleep at the surface, unless they have the power of suspending the respiratory function; and if whales sleep at the surface they ought to be constantly encountered—and, what is more, run into—while in this condition, which is not the case.

In the main the classification of cetaceans adopted in the guide is the same as that to be found in most text-books. The author, Mr. Lydekker, has, however, followed recent authorities in separating the beaked whales from the sperm-whales (*Physeteridæ*) as a separate family, *Ziphiidæ*, while he likewise sunders the two estuarine and freshwater dolphins of South America from the family typified by the susu (*Platanista gangetica*) of the Indian rivers. All these three curious dolphins are well represented in the collection. Among them the La Plata dolphin (*Pontoporia blainvillei*, fig. 1) is remarkable for its uniformly light brown colouring, which harmonises exactly with the tint of the coffee-coloured water discharged by the Rio de la Plata into its estuary.

* "Guide to the Whales, Porpoises, and Dolphins (Order Cetacea) exhibited in the Department of Zoology, British Museum (Natural History)," London. Printed by order of the Trustees, 1909, pp. 1+47, illus.; price 4d.

To the ordinary public whales are chiefly of interest on account of the huge bodily size of some of the best-known representatives of the group; and, despite the fact that the biggest species of all is not yet shown, there is sufficient in the exhibit to satisfy this very natural interest. The large models comprise, for instance, the sperm-whale, with its 54 feet of length, two kinds of rorquals, and the black right-whale of the North Atlantic. A right-whale, we may perhaps remind our readers, is a whale which yields commercially valuable whalebone, of which the best is the product of the Greenland species. Unfortunately that species is at present represented in the collection only by the lower jaw, and a few blades of whalebone, some of which measure as much as a dozen feet in length. A complete skeleton of the Greenland right-whale, with the whole of the whalebone in place, is, indeed, one of the crying needs of the Museum; but as whalebone now sells for about £2500 per ton, and a full-grown whale carries rather more than a ton-weight in his mouth, this is a want not likely to be soon supplied, unless some millionaire comes to the rescue. If this notice should induce such a personage to come to the nation's aid in this matter, the sooner he makes the offer the better, as the Greenland whale stands in imminent danger of extermination at no very distant date.

Of the other large whales, some, like the hump-back, are represented in the collection by miniature models.

Great interest attaches to the curious variety of shape exhibited by the skull in different species of cetaceans, and the variation in the matter of teeth. Dolphins and porpoises have, as a rule, a complete series of teeth in each jaw; but in the larger members of the group there is a more or less marked tendency to discard the teeth. The sperm-whale, for instance, carries teeth only in his lower jaw, although his extinct ancestors had them in both; and the beaked whales have gone a step further, and reduced their lower dentition to a single pair, or at most two pairs. Whalebone whales have advanced to an altogether different stage, and have discarded teeth in favour of the plates of whalebone depending from their palates, by means of which they strain off the sea-water from their food.

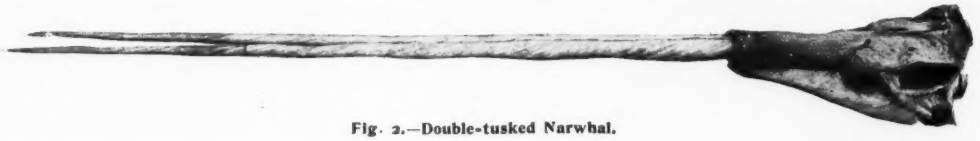

Fig. 2.—Double-tusked Narwhal.

The female narwhal, again, is an altogether tuskless creature, although the male carries one spear-like, spirally twisted upper tusk, usually the left, projecting from his blunt and rounded muzzle. Occasionally, however, a narwhal develops a pair of these tusks (fig. 2), and it is very remarkable that in such instances the spiral of both tusks runs in the same direction, instead of being in one tusk the reverse of what it is in the other, as in the the horns of antelopes. Very curious, too, is the strap-like form assumed by the single pair of lower teeth in Layard's beaked whale of South Africa (fig. 3), in which

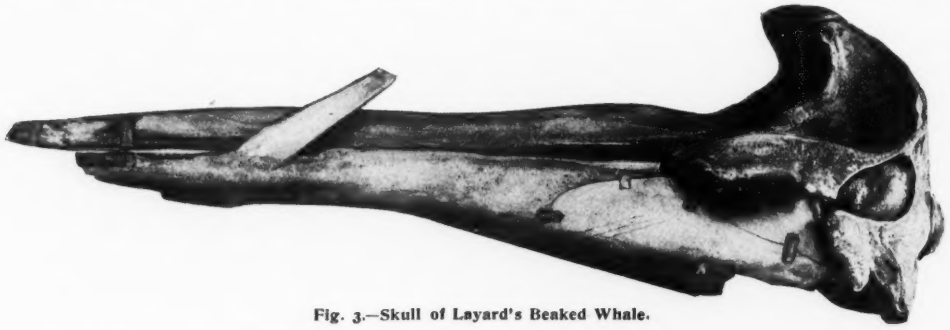

Fig. 3.—Skull of Layard's Beaked Whale.

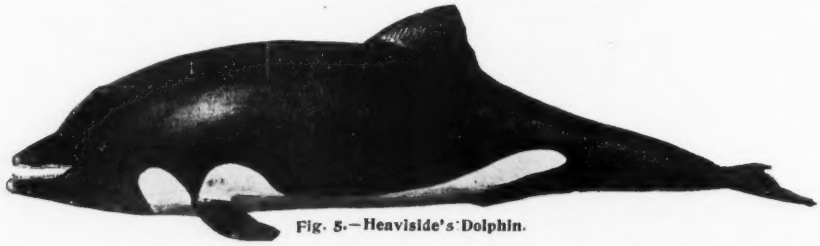

Fig. 5.—Heaviside's Dolphin.

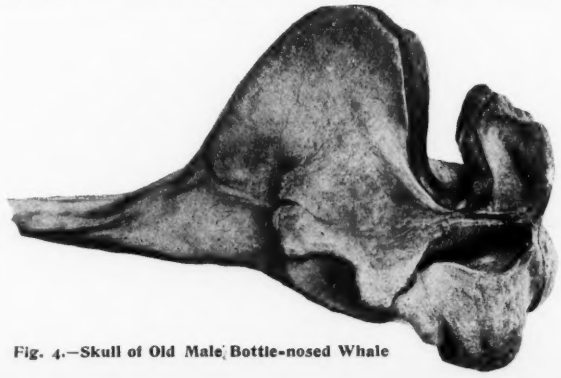

Fig. 4.—Skull of Old Male Bottle-nosed Whale

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November 15, 1908.

November 17, 1908.

Morehouse's Comet.

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these teeth actually grew above and across the upper jaw, so as to render it somewhat difficult to imagine how the creature manages to open its mouth to a sufficient extent.

Of the many peculiar modifications of the skull exhibited by various members of the order, space permits of reference only to that of the male bottle-nosed whale—remarkable for the huge crests above the upper jaw (fig. 4).

Grampuses, porpoises, and dolphins are, of course, well represented in the collection, but we can direct attention only to two—the killer and the small Heaviside's dolphin (fig. 5), both of which are remarkable for a type of colouring which has almost certainly some connection with their pelagic mode of life.

With the guide-book in his hand, the visitor who can devote a morning to the whale-room ought to be able to learn at a very small expenditure of trouble all the leading features in connection with the structure and taxonomy of cetaceans.

CORRESPONDENCE.

U.F.C. Mission House,
Gowalia Tank Road, Bombay,
To the Editors of "KNOWLEDGE."

DEAR SIRS,—Herewith I am enclosing the photograph of a Talipot Palm (*Corypha*) in bloom, taken on March 4, 1909, at the Elphinstone Circle, Fort Bombay.

It blossoms only once in a lifetime and then dies.

The Elphinstone Circle had no trees of any description in 1869, when I first came to Bombay. Shortly after, in 1870, a garden was planted. So this tree is about 40 years old.

The blossoms, which are at the top, are as yet green and unexpanded, while the leaves are already withering.

Yours truly, C. T. PETERS, M.B.,
Lt.-Colonel M.B. (retired).

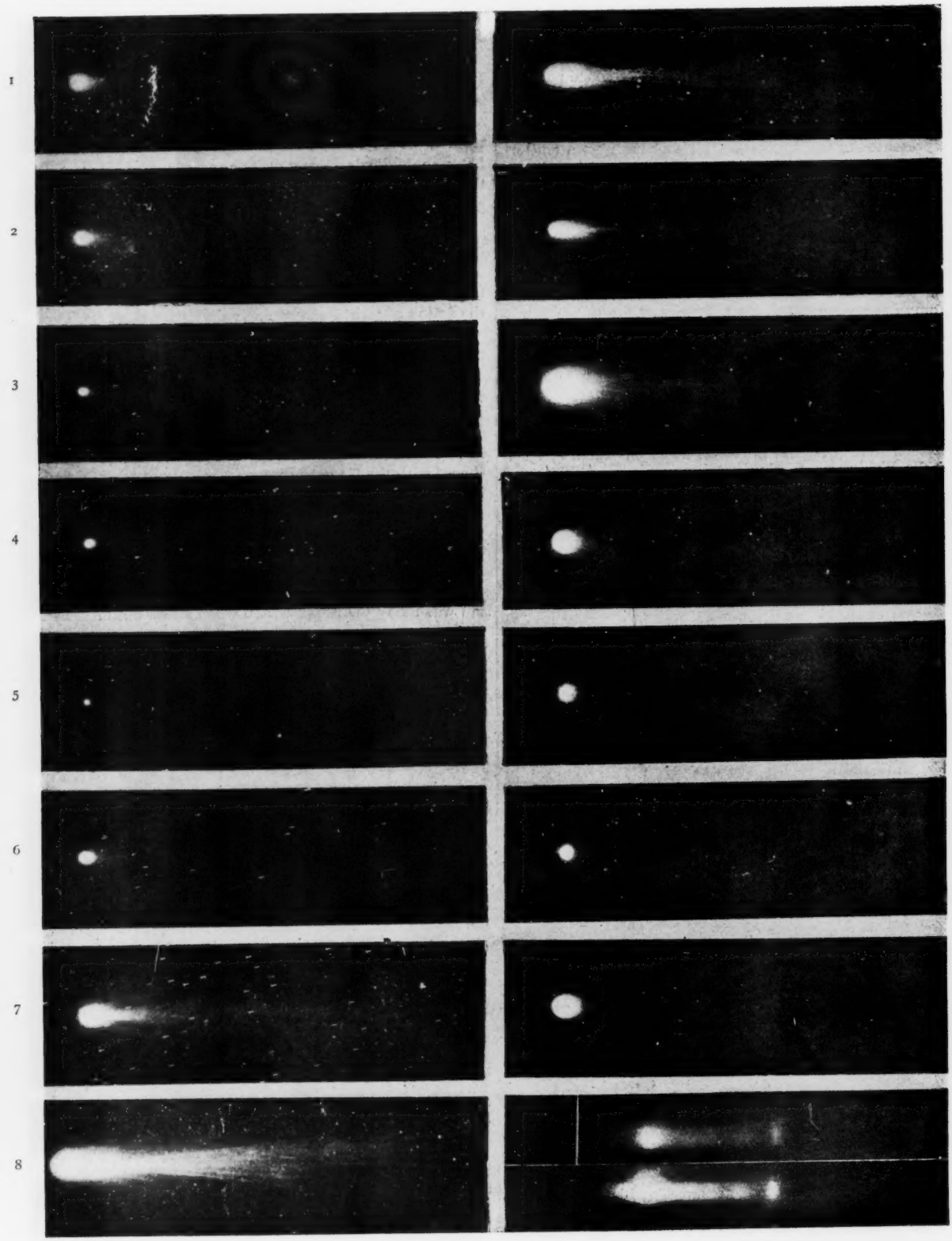
Dinagepore, E. B. and A., India,
March 24, 1909.

The Life of a Comet.

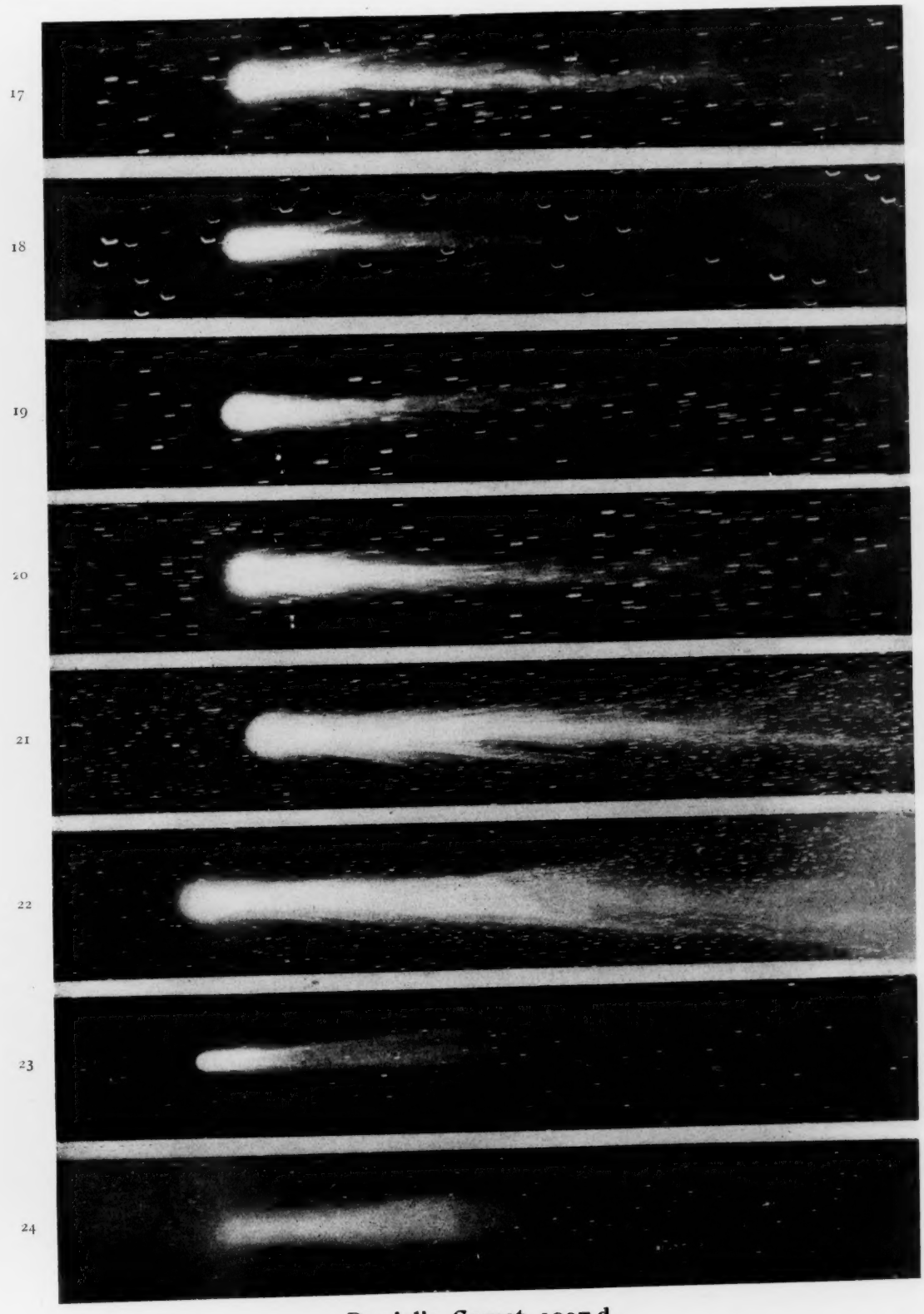
IN an article by Mr. A. C. D. Crommelin, F.R.A.S., which appears in the current number of *Science Progress*, and which deals with the expected return of Halley's Comet, he remarks on some aspects of resemblance between Halley's Comet at its appearance in 1835 and the Comet Morehouse. The nucleus in each case appeared to be in a state of great activity, and ejected streams of matter in various directions with a violence that has been compared to a volcanic outburst. These streams are at once repelled by the sun, the repulsive force being either of an electrical nature or being simply the action of light on very finely divided matter. "The main tail is directed almost exactly away from the sun, but there are a number of lateral tails or brushes making various angles with this. It was shown by Bessel that some of the changes could be explained by supposing that the comet was rotating in about five days. A similar suggestion was made for Comet Morehouse. . . . Another feature that Halley's Comet in 1835 shared with the Comet Morehouse was that both at times lost their tails for a short period. Since we may be sure that the sun's repulsive action did not cease, we must suppose that this arose from some change in the head of the comet, the nature of which we cannot guess. Comet Morehouse seemed to have a fairly regular cycle of changes, so that it was even possible to predict when the tail was likely to disappear, and when a new outburst was likely to occur."

An almost continuous series of photographs was obtained of Comet Morehouse through the co-operation of several observatories; and we have yet to receive those which were made in the Southern Hemisphere after the comet had passed beyond the reach of northern observers. A most striking series of photographs was obtained by the Rev. Joel Metcalf at the Observatory, Taunton, Massachusetts, and these have been published by Harvard College Observatory. Two of them we reproduce. The instruments employed by Mr. Metcalf were two doublets of his own construction. The first of these has an aperture of 12 inches, and a focal length of 87·5 inches. The second doublet has an aperture of 5·8 inches, and a focal length of 20 inches. The method which he has used so successfully, in discovering and following asteroids, was employed after September 15. The cross wires of a finding telescope were kept upon the image of a star, while the plate was moved every minute, by an amount, and in a direction, equal to the theoretical motion of the comet as determined from its ephemeris. This method proved particularly advantageous, since this comet had no well defined nucleus which could be used for following in the ordinary way. The effectiveness of the method is shown by the smoothness of the trails of the stars. In all cases, two photographs were obtained simultaneously with these telescopes, except on November 12, when the smaller instrument only was used.

By observation of the several features of the tail it was possible to trace their direction and speed as they were repelled from the head of the comet. The repulsive force was shown to be considerably stronger than gravitation, so that clearly the comet loses altogether what the head



Daniel's Comet, 1907 d.



Daniel's Comet 1907 d.

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appears to part with; and it is easy to understand why Halley's Comet has appeared less terrific at recent returns (and probably may be quite insignificant in appearance next year) than when it struck dismay into the minds of people some centuries ago. Mr. Crommelin thinks that Halley's Comet will almost certainly be found this autumn; and he thinks that the most probable date of its perihelion passage will be April 16, 1910. It will be nearly stationary in Pisces in January and February, and probably visible with small telescopes, possibly even with the naked eye. It will then pass behind the sun, being a fairly bright morning-star in April and the beginning of May. It will again pass the sun on May 17, and for a few days after this may be expected to be at its greatest splendour, and distant only twelve millions of miles from the earth. It is likely then to make its best display to observers in the Southern Hemisphere.

Some idea of the information which co operative photography can now give us concerning the form and movements of recent and prospective comets may be gathered from the accompanying series of plates of Daniel's Comet (1907d). These have been assembled by Harvard College Observatory and republished in Circular 144. A list of the photographs taken at Harvard and at the Arequipa Observatory is given in the accompanying table, the successive columns give the date, the Julian Day and decimal following Greenwich Mean Noon, the instrument, the time of exposure in minutes, and the corresponding number of the figures in Plates I. and II. In the third column, the letter "a" indicates that the instrument employed was the 24-inch Bruce telescope, "b" the 8-inch Bache telescope, "i" the 8-inch Draper telescope, and "m," a 1-inch Cooke anastigmat. The Draper telescope is mounted at Cambridge, the other instruments at Arequipa.

In Plates I. and II. the contrast is increased by using double contact prints instead of the original negatives.

TABLE.

LIST OF PHOTOGRAPHS.

Date.			J. D.	I.	Ex.	Fig.
	1907.				m.	
July	12	.. .. ..	7769·803	i	20	1
,,	12	.. .. ..	7769·831	i	10	2
,,	13	.. .. ..	7770·800	i	10	3
,,	13	.. .. ..	7770·821	i	30	4
,,	14	.. .. ..	7771·829	i	10	5
,,	18	.. .. ..	7775·815	i	36	6
,,	21	.. ..	7778·815	i	30	7
August	4	.. .. ..	7792·901	a	10	11
,,	4	.. .. ..	7792·902	b	30	8
,,	4	.. .. ..	7792·916	m	48	9
,,	4	.. .. ..	7792·917	b	10	10
,,	4	.. .. ..	7792·919	a	1	12
,,	4	.. .. ..	7792·925	a	1	13
,,	5	.. .. ..	7793·858	a	1	14
,,	5	.. .. ..	7793·875	b	60	17
,,	5	.. .. ..	7793·898	m	80	18
,,	6	.. .. ..	7794·891	b	60	19
,,	7	.. .. ..	7795·887	a	1	15
,,	7	.. .. ..	7795·888	b	60	20
,,	11	.. .. ..	7799·895	b	33	21
,,	17	.. .. ..	7805·909	b	28	22
,,	21	.. .. ..	7809·908	b	30	23
,,	25	.. .. ..	7813·914	b	20	24

The scale of figures 11, 12, 13, 14, and 15 is 60 ins. = 0·1 cm.; for figures 8, 10, 17, 19, 20, 21, 22, 23, and 24 it is 179 ins. = 0·1 cm.; for figures 1, 2, 3, 4, 5, 6, and 7 it is 163 ins. = 0·1 cm.; for figures 9 and 18 it is 180 ins. = 0·1 cm. The last two photographs were enlarged 3·4 times, to bring them to this scale.

Photograph of the Moon.

THE portion of the moon represented is the Mare Serenitatis and Mare Tranquillitatis with part of the surrounding surface. This section of our satellite includes a number of interesting features. The M. Serenitatis is about 433 miles N. to S. and 424 from E. to W., and includes a number of craters, among them Linne, not far inside its E. border, in reference to which Schmidt announced physical change in 1866. Formerly a deep crater, and described as such by old selenographers, it was stated to have been filled up and to present the aspect of a large white spot. Every lunar student surveyed this object with scrupulous care, only to find, however, that the supposed alteration of shape could not be absolutely substantiated. Linne, in fact, consists of a small deep crater, situated in the

midst of a large white spot. Under usual illumination the crater is obliterated, and the white spot assumes undue prominence; but when near the terminator the writer has seen the small deep crater very plainly in a 12·6-inch reflector, powers 315 to 440.

Bessell is the largest of the crater pits scattered over the M. Serenitatis. It is 14 miles in diameter.

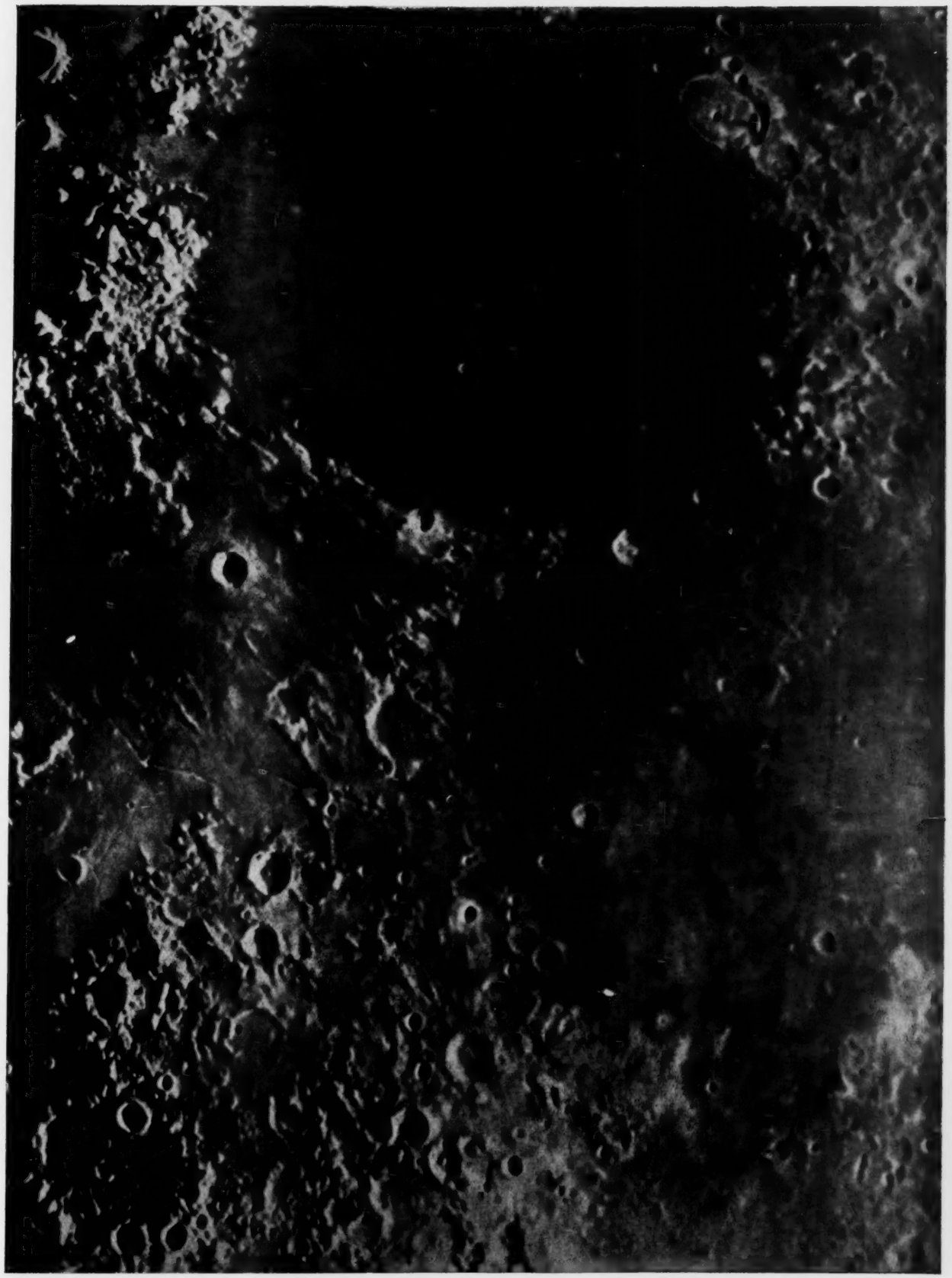
Posidonius is a large walled plain 62 miles across, containing seven clefts, and affording a fine aspect a day or two before first quarter.

Plinius and *Dawes* are two craters on the region connecting the two Maria and N. of M. Tranquillitatis. The former is 32 miles in diameter.

M. Tranquillitatis is a very large grey plain in which much detail can be traced; part of it is placed in the S. part in N. hemisphere.

Arago forms a fine ring-plain 18 miles in diameter.

East of *M. Tranquillitatis* are some very complicated and extensive rill systems; these will be found near



Reproduced by kind permission of the Directors of the Paris Observatory.

The Moon.

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Triesnecker, *Hyginus*, and *Silb·rschlag*. Actual changes have been more than once supposed to have modified the aspect of these regions, but absolute proof is still lacking. Drawings of lunar objects often err in important details, and it is to the future comparison of photographs that we must ultimately look to solve the problem as to whether or not our satellite is still in the active stage. A shallow crater near Hyginus marked N attracted much attention some years ago, but the suspected alteration was not proved on ample evidence.

Godin and *Agrippa* are figured in Neison's *Moon*, p. 161 and 162. They are ring-plains, 23 and 27 miles in diameter.

Rhæticus, to the E. of the last pair, occupies a position on the moon's equator. The highest point in its wall is 5000 feet in elevation.

Hipparchus is a large irregular formation about 92 miles in diameter, and including rills, craters, hillocks, in fact, many varieties of formation are within its limits. It is placed just on S.E. corner of photo., and several deep craters will be seen on its borders.

Autolycus and *Aristillus* are two deep conspicuous craters on N.E. corner of photo. Their W. sides have just come into sunlight. Aristillus is the larger of the pair, being 34 miles across and about 11,000 feet deep on E. side.

In addition to the formations specified, the photograph contains hundreds of others, some of them of extreme interest and importance. They may be identified and particulars gained about them from Neison's or Elger's *Moon* or Webb's *Celestial Objects*.

Wireless Longitude.

THE longitude of a vessel at sea is found by noting the difference between the time at Greenwich or any other standard meridian and that of the meridian of the vessel, as determined by observations. In order to eliminate error due to inaccuracy of the chronometer, it has been proposed that time signals be transmitted at regular intervals from a land station, such as the Eiffel Tower. This would do away with the use of the chronometer, as the signals could be transmitted practically instantaneously to the vessels. In order to test the efficiency of such system, a set of signals were sent out from the Eiffel Tower, and were received at the Brest Observatory, where it was found that the maximum variations were not more than half a second.

Sterilisation of Water by Light.

THE mercury vapour lamp with a tube of quartz emits a large proportion of ultra-violet radiations, the bactericidal properties of which were established by Nogier and Thévenot in 1906. Courmont and Nogier have recently endeavoured to utilise this property in the sterilisation of drinking water. A Kromayer lamp, of 9 amperes and 135 volts, was suspended in an iron cask filled with water. All bacteria (including the coli bacillus and Eberth's bacillus) within 12 inches of the lamp were killed in two minutes. A long series of experiments proved conclusively that one minute suffices for complete sterilisation in ordinary cases, and two minutes when the water is very greatly contaminated, either naturally or artificially. The water, however, must be clear, in order that the rays may pass through it. The elevation of temperature is only a fraction of a degree and the water, after treatment, is harmless to plants and animals. Hence it appears practicable to sterilise the water supply of a city (after clarification, if necessary) by distributing powerful quartz mercury vapour lamps in the reservoirs of the mains in such a manner that every particle of water shall remain two minutes within a few inches of a lamp.

Burrowing Animals.

By W. P. PYCRAFT, F.L.S., F.Z.S., M.B.O.U., &c.

(*Continued from page* 131.)

AMONG the mammalia, and among the birds, as we have shown, very considerable power and skill in burrowing may be attained without, in any perceptible degree, demanding structural changes, such as would cause the creature in question to differ from its non-burrowing fellows. Only, it would seem, when digging becomes a matter of life and death, when the daily bread is to be obtained only from subterranean sources, are manifest structural changes brought into being. As a consequence of the mechanical requirements of such a mode of life, certain conditions are imposed, as it were, upon all which, from one cause or another, have been drawn within this moulding force. And hence animals in no way related have come to bear a very striking resemblance, though in many cases a closer examination will show that the same end has been gained by different means, as for instance may be seen in contrasting the common mole (*Talpa europea*) with the golden mole (*Chrysochloris*) and the marsupial mole (*Notoryctes*). In the first-named the hand retains all its fingers, but has become enormously widened—the hand has been retained in its entirety. In the last two the work of digging has been thrust upon two fingers armed with enormous claws. But the most striking case of this resemblance between unrelated forms is furnished by the mole-rat (*Spalax typhlus*) of S.E. Europe and the mole-vole or zokor (*Myospalax fontairieri*) of N. and Central Asia. These two animals bear the most marvellous resemblance one to another, which is all the more remarkable because this resemblance includes a most unusually broad and flattened head. Only by the larger size of the feet in *Myospalax* can the two be distinguished, externally, one from another. As will be shown presently, however, superficial likenesses of this kind are not confined to the mammalia.

Let us pass now to the reptiles. The burrowers in this group afford a striking contrast with the burrowing mammals, since so far from having developed powerful digging feet, they are limbless! And hence they have come to assume a remarkable resemblance to snakes. Now if snakes were less well-known creatures it might be assumed from this that snakes were also burrowers! Therein do they show how unwise it is to prophesy before you know!

The most highly specialised of all the burrowing reptilia are the Amphisbænas of tropical America, Africa, and S. Europe. Worm-like in shape, these creatures have lost the typical overlapping armour of scales, and have the body encased in a soft skin drawn into rings, and containing vestiges of scales. From the difficulty of distinguishing the head from the tail, and from their ability to move either backwards or forwards with equal facility, these creatures were in olden times regarded as two-headed snakes! They are not indiscriminate burrowers, but must be sought for in ants' nests and refuse heaps.

Having regard to their condition, the geographical range of these creatures is surprising, for they are to be met with in tropical America, Africa, and S. Europe. This fact and certain structural peculiarities lend support to the suggestion that has more than once been made that these creatures do not form a natural group. That is to say, they are so many instances of "convergence"—of the effects of a similar mode of life in unrelated forms.

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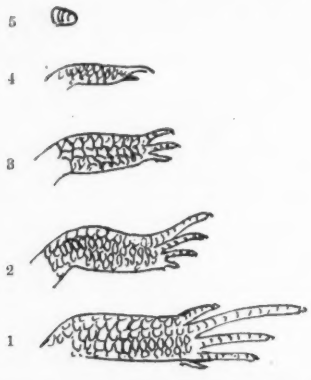
Snake-like though they be, they are really lizards, as is proved by their internal structure. One genus indeed, *Chirotes*, yet retains short four-fingered fore-legs.

This snake-like form has been assumed by other lizards which, it is to be noted, are not burrowers, our common slow-worm and the curious "glass-snake," or "Scheltopusik" (*Ophisaurus apus*), of S. Europe, for example. The stages by which this limblessness have come about are interesting. In the first place, as the



Hind Legs of Skinks, to show gradual degeneration.

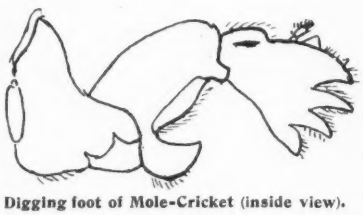
1, Chalcides ocellatus; 2, C. mionecton; 3, C. tridactylus; 4, Lygostoma linco-punctatum; 5, Chalcides guentheri.

Foot of Pelobates cultripes (Spade-foot Toad), to show the digging spur—shaded black.

limbs have degenerated the body has proportionately increased in length, and this in the region of the trunk only—the region between the fore and hind limbs. And almost every stage in this process of evolution may be followed in the lizards known as the Skinks. The nature of this degeneration is indicated in our illustration.

The Amphibia have also produced not a few burrowers,

Cylindrodes Kochii.



Digging foot of Mole-Cricket (inside view).

and, like the reptiles, some which, while having a similarly cylindrical body, are not burrowers. The snake-like burrowers are represented by the curious "Cœcilians," which in many respects recall the Amphisbænas among the reptiles. For the most part they live in mud, or very soft moist soil; some are aquatic. But there are burrowers among the Amphibia which have succeeded in evading the usual penalty levied upon burrowers. Such, for example, are the claw-heeled, or "spade-foot" toads (*Pelobates*), which differ from their relatives in having upon each hind foot a little shovel-like plate encased in horn, and therewith they dig themselves holes in the ground for concealment during the day.

The frogs, however, of the genus Breviceps, found in S. Africa, have undergone more change in adaptation to a burrowing habit, and here, it is significant to note, the burrowing is performed in the pursuit of food. The body is here short and stout, and the snout is pointed. Like the spade-footed toads, the hind leg is armed with a "shovel"; but the near relatives of the genus Breviceps, the frogs of the genus *Hemisus*, dig with the fore-feet.

Among the fishes the best known burrowers are the eels; and these need no description here.

Let us turn now to the burrowers among the invertebrates, selecting therefrom only a few of the more striking instances.

The Mollusca and the Echinoderms may boast the most remarkable burrowers to be met with in the whole animal kingdom, for they will drive tunnels into the hardest rock.

In the former group the burrowing organ is the foot. As in other animals, perfection in burrowing is accompanied by an elongation of the body, and consequently of the shell, which, to allow egress for the foot at one end, and the respiratory siphons at the other, is open at both ends, as in the well-known "razor-shell." But the great exponents of the art of burrowing are mussels, known as "Date-shells," and the piddocks (*Pholas*), which will contrive to make themselves comfortable under any circumstances apparently, for they will burrow with equal ease into clay, chalk, limestone, or even gneiss! They are probably enabled to accomplish the feat of boring into hard rock by the aid of some solvent secreted by glands in the foot aided by the edges of the shell, which are used as a file. Teredo, a cousin of the piddocks, known also as the ship-worm, is a wood-borer, and before the days of copper-sheathing inflicted immense damage on shipping, and brought the dykes of Zealand and Friesland within an ace of utter destruction. The shell of this creature is small, but the siphons, which may measure as much as 3 feet long, form for themselves a shelly tube, the apertures of which can be closed, and this tube forms a lining to the burrow.

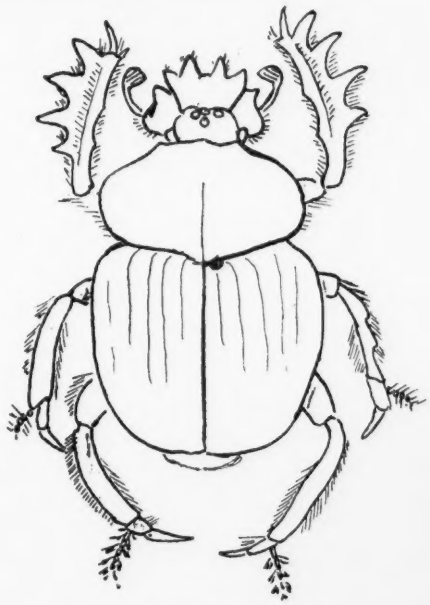
That the sea-urchins, among the Echinoderms, can boast burrowers of no mean skill is surely a matter for surprise. But the genus *Strongylocentrotus* contains some species which contrive by means of their teeth and spines to excavate deep cups in solid rock wherein they secure shelter from the wash of waves, to which, living between tide-marks, they are subjected.

Passing now to the insects we meet with forms among which burrowing seems a less unnatural, and, in a way, a less wonderful performance, since these, like the vertebrates, are limb-bearers. And among these horny-armoured animals we meet with forms which have a peculiarly familiar look, such as, for example, is presented by the mole-cricket. Herein the body is long, while the fore-limbs are short, broad, and armed with claw-like spines, resembling stumpy, pointed fingers, so that the general appearance of the creature is strangely reminiscent of the mole, which, in its mode of life, it so closely resembles. A near relative of the mole-cricket, *Cylindrodes Kochii*, has become even more transformed by this underground life; but it presents one remarkable difference, to wit, the digging-apparatus is not fashioned out of the extremity of the leg—the "tarsus"—but is formed by the tibia, the segment next above it, which is accordingly produced far beyond the normal length. While

excavation is going on the frail tarsus is bent back out of harm's way.

Among the beetles are many burrowers, and some, such as the Scarabæids, have enormously powerful fore-limbs armed along their hinder edges with strong, rake-like teeth.

Finally we come to the rodent burrowers, exemplified by the larval stages of many beetles and moths. Many of these excavate long tunnels in wood, by means of their jaws, but, save that these jaws are powerful, they do not exhibit any very special adaptation for a burrowing life. This is explained by the fact that they do not have to move over large areas in search of food.



Scarabæus sacer, to show digging feet.

Among adult rodent burrowers the ants and the spiders are the most skilled craftsmen. The latter are veritable Sybarites, lining their burrows with the softest silk. The trap-door spider is perhaps the most cunning workman of all, for it drives long, silk-lined tunnels into the earth, and closes up the entrance to the burrow by means of a lid which, on its upper surface, is made to harmonise so perfectly with the surrounding soil that when in position detection is impossible.

In this survey of burrowing animals only the more striking examples have been discussed, and these seem to show that direct adaptation to burrowing, that is to say, fundamental structural modification, is met with only when such modification has been necessary to ensure success in the struggle for existence.

The Watkins' Manual of Exposure and Development, by Alfred Watkins (Hereford: The Watkins Meter Company; fourth edition, 1908; price 1s. net).—This well-known and much-appreciated manual varies in the new from the previous edition chiefly in the addition of a section on "thermo-development," that is, development without inspection for a period that, for any certain developer, varies according to the temperature. As with the other subjects, the author explains this matter in a simple way, and although he refers to the conveniences that the Watkins Meter Company has put on the market, he gives instructions of a general and fundamental kind.

India Rubber.

Rubber-Yielding Plants; their Cultivation.

BY HENRY P. STEVENS, M.A., PH.D., F.I.C.

OWING to the progress made by the rubber plantation industry in the East, and the growing demand for this product, in particular for the manufacture of motor tyres, the subject is one of increasing importance, and the Editor of "KNOWLEDGE" has asked me to revise some old notes on India Rubber, bringing the subject up-to-date so as to present a short account of the industry and of our present scientific knowledge of the subject. We are now at the opening period of a rubber age and the increasing use of this material is exerting its own influence on our every-day life. It would be difficult to exhaust the list of articles for which rubber is used at the present time, and still more difficult to complete a list for which it might be used, were not its present price prohibitive. We are continually meeting with

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Fig. 1.—Jungle felled and burnt off ready for planting rubber.

fresh uses to which it has been adapted, and the supply is inadequate to the demand, which resulted in a gradual and steady rise in the price of the crude material until May, 1905, when fine hard Para, the standard rubber, fetched 5s. 9d. The acute commercial depression of last year brought the price down to 2s. 9d., from which time the price improved, and to-day is about 5s. 3d. per lb. There is no reason to expect any considerable fall in price in the near future, as no rubber substitute has been discovered which can in any way compare with the natural product—there is no lack of inventions, and substances have been prepared which distantly resemble rubber, but have not its peculiar qualities; secondly, the cultivation of rubber-yielding trees has not been carried on long enough to influence the output for some few years to come. Rubber is the product of the coagulation of a milky juice which can be obtained from certain trees growing mostly in tropical climates. Many varieties of trees yield this milky juice or Latex, when the external bark is damaged or cut. Some are forest trees growing to a great height, others are climbing plants growing in wild luxuriance in tropical forests. Some favour moist, damp climates, as the "Hevea Brasiliensis" of the low-lying valleys and uplands of the Amazon district, which

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yields the celebrated "Para rubber," while the "Castilloa Elastica" of Mexico and Central America, although favouring a hot, moist climate is able to withstand a dry season if not too prolonged. I mention these two in

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Fig. 2.—Young hevea trees about eighteen months old.

particular as considerable advance has been made in the rational cultivation of these trees on a large scale, the former in the Federated Malay States, the East Indies,

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Fig. 3.—Hevea trees about 5 years old.

and Ceylon; the latter in Mexico and the Central American States. To collect the Latex, in the Amazon districts, incisions are made by means of a small axe in the bark of the tree. When properly tapped the tree can be bled at intervals yielding a good supply of Latex without permanently damaging it, but in some countries, as in Africa, many trees have been damaged by careless tapping and others have even been cut down or wantonly destroyed. The collectors have to penetrate into the tropical forest, which in the valleys of the Amazon is at times a fever-ridden swamp. As the Para rubber which comes from this district holds a unique position on the market, it is easy to understand the importance of the rational cultivation of this particular tree.

The cultivation of "Hevea Braziliensis" is most advanced in the Malay Peninsula, although a very large acreage has been planted up in Ceylon. In the first place I shall describe shortly the general method employed in opening up an estate. Assuming the land to be jungle, this is first felled and burnt off as in opening land for cultivation of any tropical product (Fig. 1). The trees are raised from seed which takes from two to three weeks to germinate. Under natural conditions the envelope containing the seeds bursts with a slight explosion, scattering them broadcast. As a rule they are first planted out in a nursery. It is not usually expedient

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Fig. 4.—Hevea trees about seven years old, at Cross Roads on an Estate.

to plant them out direct on the estate, as they are liable to destruction by rats and other pests. When the young plants have grown to the height of about 12 inches, they can be planted out, if care be taken that the roots do not suffer any damage. It is, however, usually better to leave them for nine to twenty-four months, then cutting off the tops to within about 3 feet of the ground; they are pulled out as "stumps" and the roots trimmed and then planted out. In the latter case it may be some time before they throw out young shoots—generally two or three months is sufficient, but plants have been known to be dormant as long as nine months and then to grow up quite strong and healthy. Once planted out they require very little attention beyond being pruned once or twice, and watched for white ants and other pests and diseases. The growth of the trees (Figs. 2, 3, and 4) is remarkably rapid, and they begin to yield seed between the third and fourth years. The quantity at this age is, however, insignificant, but increases enormously with each succeeding year. There are two seed crops in the year, the first and smaller one occurring about February to March, the second (and by far the larger one) in September and October. The age at which the tree should first be tapped is a matter of much difference of opinion. Some advocate an early tapping—*i.e.*, when

the trees are only four to five years old—on the ground that a tree, say, six years old, will yield more rubber when it has been previously tapped than if it had been left untouched. Others maintain that trees should be allowed to reach the age of six or even seven years, so that they may have time to mature before being tapped. The arguments in favour of early tapping seem to have been established by experiment, and the custom is now usually adopted, seeing that the companies owning the estates are naturally desirous to enter the producing stage as soon as possible and to begin to show a return on the capital outlay. It is a good practice to tap all trees of five years of age which have attained a growth of 17 inches at a height of 3 feet from the ground. Trees can be tapped every day, or every other day, and there is no generally accepted rule as everything depends on the rate at which the bark is removed in the tapping process. It is generally recognised now that bark should be given four years to renew itself before being cut again, so that a method of tapping which removes but little bark can be applied more frequently than one which cuts away at each operation a large proportion of bark. The lactiferous cells are found just outside the cambium, so that if properly cut there is no need to damage

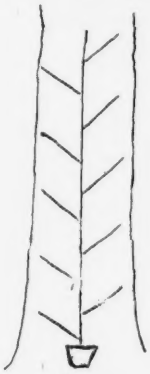

Fig 5.

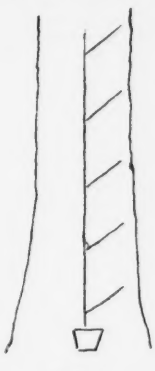

Fig. 6.

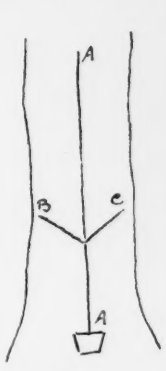

Fig. 7.

the tree. There are three methods of tapping in vogue (Figs. 5, 6, and 7). (1) The herring bone. Incisions are made as shown in Figs. 5 and 8. At the foot of the vertical central channel a tin spout is driven into the bark by which the Latex is conducted into a small metal cup of tin or aluminium suspended on a nail below. The lower side of the lateral cuts are reopened at intervals of 24 hours or more by cutting off a thin piece of bark. The height to which the herring bone is carried is four to six feet; the size and number of the lateral cuts, depends, of course, on the size and age of the tree.

(2) Quite as common as the herring bone is the so-called half herring bone (Fig. 6), in which lateral cuts are made on one side of the vertical channel only. When working on this system the tapping area from which the bark is being removed comprises a quarter segment only of the trunk, while in the full herring bone the bark is removed from the whole of one side of the tree. From this it follows that if with the latter the four to six feet of bark working down the runk of the tree be removed in two years with the half herring bone it can be done in one year, and it will still take four years to completely strip the bark from the tree.

(3) V-shaped incision (Figs. 7 and 9). On the first day the central cut A, and the lateral cuts B and C are made and then at each tapping the lower side of each lateral cut is opened by removing a thin shaving of bark. In this case the edge of the cup is forced into the bark just below the cut to receive the Latex. Numerous other methods of tapping have been suggested from time to

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Fig. 8.—Hevea rubber tree about 12 years old, tapped on the herring bone system. The lines showing up white are caused by the latex oozing from the fresh cuts.

time, but with few exceptions one or other of the above methods are now universally employed. From what I have seen on estates in the East the single V, which

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Fig. 9.—Hevea trees showing tapping by the single V method. The latex has ceased to flow, and the cup has been removed from the bottom of the tree but sufficient remains in the cuts to show white on the tree on the left-hand side in the foreground.

is the method adopted on one of the best estates, appeals to me more than the others on account of its simplicity and the small amount of bark removed at each tapping.

A great variety of knives have been devised for tapping, the object being to cut deep enough to sever the Latex vessels, but not so deep as to cut into the cambium; but much more depends on the skill and care exercised by the coolie than on the particular form of knife.

Figs. 2, 3, 4, and 8, showing trees at different ages, will give an idea of the rapid growth and development in the Malay Peninsula.

When rubber trees are cultivated in accessible districts the coagulation and extraction of the crude rubber from the Latex can be done on the spot. The advantage of this method of procedure we shall appreciate shortly. Many of the methods of coagulating the Latex in remote districts are extremely inefficient. The best of these, which is in vogue in South America and some other parts of the world, was empirically discovered and although very tedious is yet satisfactory. The collector (seringueiro) having penetrated sufficiently far into the forest and selected his field of operations, makes incisions in the bark of the trees, and allows the Latex to collect in small cups (tigelinhas or tichuelas) such as I have already described. The Latex is emptied into a large dish, and the operator (cachero) takes a wooden instrument, pallet-shaped like a canoe paddle, dips the flat end into the dish, and then holds it in the smoke issuing from a conical shaped vessel opened at both ends and placed over a small fire. The heat and smoke coagulate the Latex and drive off the moisture, leaving a thin layer of crude rubber on the surface of the pallet. It is again dipped into the dish containing the Latex and the operation repeated until a sufficient thickness of rubber is obtained. The final result is a rounded block of crude rubber, which is split vertically to free the pallet. It is quite white at first, and weighs perhaps about eleven pounds. Dr. Evans tells me that in Bolivia, where the preparation of the rubber is carried on in the manner described, these large balls are as much as a foot in diameter and take about a fortnight to make. A very large block or "loaf," weighing several hundredweight, was exhibited at the Rubber Exhibition held last autumn at Olympia. Owing to the undoubted excellence of the Para rubber prepared in this way, the process has come to be regarded as the only one which can yield satisfactory results.

NEW ZEISS CATALOGUES.—In the publications issued by Messrs. Carl Zeiss, of Jena, the latest numbers of which have just reached us, there is a good deal more than the mere enumeration of pieces of apparatus, for an examination of their contents reveals the latest developments in optical apparatus. The new catalogues embrace, for example, a description of Siedentopf's Paraboloidal Condenser, which furnishes a dark-ground illumination for microscopic investigation, and which is of great service in taking instantaneous photographs of living bacteria, especially of those organisms such as some forms of spirochætes which are not readily distinguishable. Other pamphlets descriptive of recent apparatus which are of great interest refer to improvements in large Pryedim apparatus; in the new methods of illuminating microscopic specimens by a system of collective lenses of great light-gathering power; the horizontal and vertical cameras for photo-micrography; and the apparatus for the projection of spectrum experiments and of experiments with polarised light.

Striæ on Neolithic Flint Implements.

By W. G. CLARKE.

AT recent meetings of the Royal Anthropological Institute of Great Britain in London and of the Prehistoric Society of East Anglia at Ipswich and Norwich, Dr. W. Allen Sturge drew attention to the presence of scratches on the surfaces of many humanly-worked flints, and put forward a revolutionary theory to account for them; in short, that whether the implements be Paleolithic or Neolithic, the scratches were caused by glaciers grinding quartzite over flint, or flint over quartzite. When the majority of prehistoric archæologists do not admit that Paleolithic man was pre-glacial, the suggestion is sufficiently startling, but when it is argued that many of the Neolithic surface implements were also used by man before the cessation of glacial conditions in this country, it is obvious that this apparently simple matter has in it the basis of an entire revolution of the chronology of the Stone Age and of the antiquity of man.

The most important matter at the present stage seems to be to determine the significance of the scratches on implements of undoubted human workmanship, but more particularly those of the Neolithic age, as since Mr. S. J. B. Skertchly found Paleolithic implements in the loam beneath the boulder clay at Weeting, Norfolk, in 1877, many archæologists have held the opinion that some at least of the implements usually recognised as Paleolithic are either pre-glacial or inter-glacial, so that the occurrence of glacial scratches on implements of this age is by no means improbable. But with regard to Neolithic implements the alteration in current beliefs necessitated by proof of the pre-glacial origin of any of them would be stupendous. Although the data concerning the great glacial period are admittedly uncertain, the most generally accepted opinion has been that the end of the period could be placed at about 80,000 years ago, while few authorities have hitherto suggested an antiquity of more than 20,000 years for the beginning of the Neolithic stage of culture. Should Dr. Sturge's theory be accepted, either the glacial period must have extended much nearer to our own time, or Neolithic man must have had an incomparably greater antiquity than has hitherto been supposed. Of these alternatives the latter seems much more probable, if only from the proof furnished by the double and treble patinations, entirely different in character, of admitted Neolithic implements.

With regard to these scratches, most collectors have probably noticed them on surface implements of various divisions of the Neolithic age, though varying greatly in appearance and intensity. Until Dr. Sturge drew attention to them archæologists who had casually noticed these scratches had probably considered them to be due to accident and to have no particular significance. Since the theory has been postulated it has been suggested that these scratches are caused by contact with agricultural implements, with men's boots, with pieces of quartz burnt into a ploughshare or harrow, or by "earth-creep." The fact that many of these striated implements are found on uncultivated and primeval heathland and on plateaux where "earth-creep" would seem to be an impossibility practically disposes of these suggestions.

I have made a number of simple experiments to determine how easy or how difficult it is to scratch fine chalcedonic flint such as that on which most of the roughly parallel scratches appear. This flint has in the

majority of cases a horn-coloured interior, with a patination resembling a bluish bloom. On this surface the scratches appear white, and the flint in the grooves more nearly resembles quartzite than flint, and is quite dissimilar in appearance to the remainder of the implement. With this particular kind of flint, and this patination, there is a noticeable tendency to parallelism in the striæ, and as the implement lies on the surface it is possible to state, before examination, that, should it

Photo.] [*F. Manning, Norwich.*

Striated Neolithic Implement of Chalcedonic Flint from Santon, Norfolk.

be a scratched specimen, the scratches will be of a certain character. By examining these striations under a microscope their peculiar character is at once manifest, and the ridiculousness of the suggestion that they are due to casual scratching immediately disposed of. It at once becomes obvious that the striations were caused by some very hard substance, under enormous pressure, the flint being fractured in all directions, thus

Photo.] [*F. Manning, Norwich.*

Glacial Striæ on Eolithic Implement from Early Glacial Gravels at Eaton, Norwich.

allowing the light to penetrate, and giving the characteristic white appearance. In many of the scratches, the bottom of the groove is fairly smooth, but the sides are so rugged and battered as to make it seem certain that the flint was ground away. When the scratches reach to the edge of the implement there are often very extensive abrasions and batterings, and it is not improbable that some of those on the edge of Neolithic implements hitherto considered as due to the utilisation of the implements by Neolithic man really owe their origin to the same cause as the scratches. When experiments are made with the object of reproducing these striations, it is found impossible by any method to which these flints might accidentally have been subjected in historic times. Any conceivable form of tillage of the land seems quite inadequate to scratch such material. On the light lands of North-West Suffolk and South-West Norfolk, where many of these striated implements have been found, when a stone is struck by a plough or a harrow it is simply forced aside or further into the soil; there is nothing on which it can be kept rigid while it is scratched by the ploughshare. But if one of these fine chalcedonic flints be fixed, and an attempt be made to scratch it with a piece of steel, using the utmost possible pressure without a blow, it will be found that the surface is absolutely undisturbed, and microscopic examination shows that instead of the particles of flint being removed, tiny fragments of steel are ground off and left on the surface. An attempt to scratch the surface with newly-fractured pieces of hard flint, using force sufficient to grind off fragments of the piece with which the effort is made, leaves the highly lustrous surface of the Neolithic implement absolutely undisturbed, nor does inspection with the microscope show that there has been any effect. With an angular piece of quartz or with a glazier's diamond it is possible after some minutes' persistent work at one spot to make an impression which can just be detected with the finger-tip and which is microscopically visible, but the flint in the minute groove is unaffected beyond the immediate area scratched, and shows no signs of splinter or fracture. By striking sharp blows it is, of course, possible to break fragments from the surface of chalcedonic flint, but it is almost needless to state that these have not the remotest resemblance to the long white striæ under consideration, and it can hardly be doubted that these were caused under such enormous pressure that the only natural means which can be suggested for their formation is that of rock-fragments in the grip of a glacier.

In his address at the Norwich meeting of the Prehistoric Society of East Anglia, Dr. Sturge pointed out that, in considering the cause of these striæ on Neolithic implements, it was necessary to remember: (1) "That humanly-worked surfaces, as well as those produced by natural causes, are scratched. (2) That the flint is generally of very fine quality, and consequently of very great hardness. (3) That the Neolithic flints lie on the surface of the ground. (4) That there are several varieties of scratching, the degree and kind of scratching varying in accordance with the variation in several other factors, which together go to prove the relative age of the implements. (5) That the scratched neoliths are more common on the higher grounds than in the valleys."

It will be natural for the geologist, the astronomer, and the archæologist who disbelieves in eoliths to attempt to ignore both the facts and the conclusions. But the evidence is not evanescent; it is always available for inspection, and will naturally tend to increase. Most collectors on examining their specimens will probably find a number which bear on their worked surfaces these deep scratches. They will be able to compare them with striated flints and erratics from the boulder clay, with eoliths on which hardly a square inch can be found lacking glacial striæ, or with paleoliths of similar appearance. They can try simple experiments, and quickly determine for themselves how utterly inadequate are any explanations that do not include something as hard as quartz applied under enormous pressure for the production of these striations. And geological knowledge affords us no other possible cause of these striæ than glacial action.

XUM

Sounding the Air.
Blue Hill Observatory Experiments.

INVESTIGATIONS of the Upper Air by means of kites are being carried on, and have been carried on for some time, in England, as well as in many other places; and information of great value may be expected to follow from the collection and correlation of the observations thus made. The height to which kites can attain is, however, limited by various considerations; and meteorological observations made by the aid of them need to be supplemented by knowledge of the conditions of temperature, pressure, and humidity at heights which can be reached only by balloons. The use of balloons for this purpose was suggested a century ago by an unknown writer; but it was

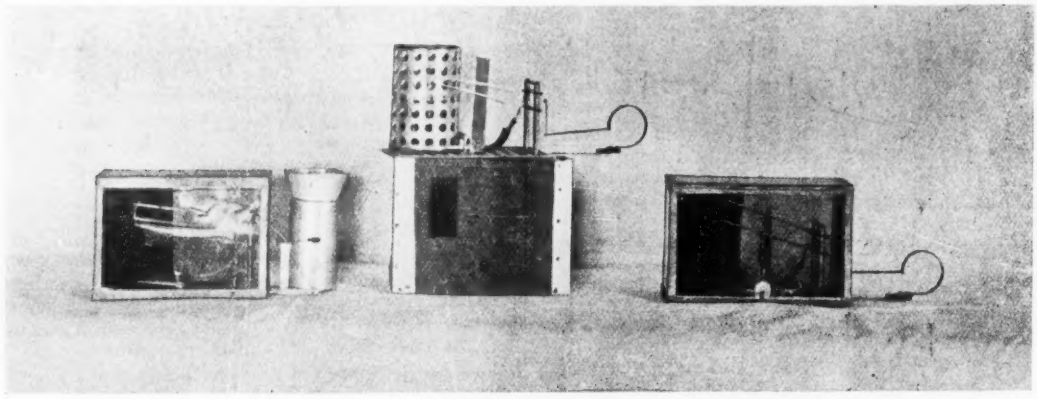
Instrument and Basket ready for Ascension.

not till March 21, 1893, that MM. Hermite and Besançon, of Paris, accomplished successfully the first trial of the new method of research by sending up a *ballon-sonde* carrying a suitable recording apparatus. In their earlier experiments MM. Hermite and Besançon sent up balloons that had nothing but cards instructing the finder to report the time and place of descent. Later a simple device for recording the extreme height attained was attached to some of them. Finally, on the date we have named, a balloon with a special instrument recording the time, pressure, and temperature was employed for the first time.

It was thought that a large proportion of the balloons would be lost (though this proved to be a groundless fear), and as theoretically in order to reach great heights the balloon must be of good size, the new method promised to be expensive. For example, in order to reach heights between fifteen and twenty miles, a balloon of 45,000 cubic feet capacity appeared to be necessary. But as a matter of fact such heights can be reached by a smaller balloon of a different kind. Another reduction of expense was due to the alteration of the material of the balloons. The first balloons of the French pioneers were made of gold-beater's skin, which, though probably the best material, is very costly. Later silk was employed. In 1898 M. Teisserenc de Bort devised a simple method of using a large paper balloon enclosed in a net. The most important improvement, however, was that of Dr. Richard Assmann, of the Royal Prussian Aeronautical Observatory. In place of the large balloon hitherto employed, Dr. Assmann substituted a much smaller one made of sheet rubber. This was filled with hydrogen and sealed. Such a balloon ascends at a nearly uniform rate till exploded by expansion of the gas, and then descends to the ground at nearly the same rate.

The capacity of these balloons usually is one to four cubic metres, or about one-hundredth that of the balloons previously employed for the purpose; and the entire work of preparing for an ascent can be done by one or two persons. A complete account of *ballon-sonde* apparatus and method, by far the most satisfactory that has yet been written in English, has been compiled by the Director and Assistants of the Blue Hill Meteorological Observatory, Dr. Lawrence Rotch and Messrs. Helm Clayton and S. P. Fergusson. The volume is published by the Harvard Observatory, and contains a number of valuable results, which may be regarded as the first instalment of the Blue Hill station to the data now being compiled by the International Aeronautical Commission, on which most of the countries in Europe are represented. Much experimental work has been done by the members of the Commission, and the literature of the subject, though scattered, is extensive.

The balloons employed at Blue Hill are obtained from Hanover, and are made of sheet rubber, so cut that the inflated balloon is spherical in form. Their diameters when distended vary from about 4 to 10 feet, and their lifting power from 2½ to 15 lbs. Hydrogen is used for inflating these balloons, and in order to secure sufficient lift the gas is forced in till the balloon is distended beyond its normal diameter and capacity. The elasticity of the rubber will admit of an expansion of the balloon to about two-and-a-half times its original diameter. That condition would be attained naturally when it rose to a height of about 60,000 feet, where the density of the air



Instruments Employed in the Experiments.

The upper photograph shows the basket containing the instrument ready for an ascent. The three patterns of instruments are—taken from right to left—the baro-thermograph with mica case; the baro-thermograph with cork case; and the baro-thermohygrograph with cylindrical thermometer screen.

is less than one-thirtieth that at sea-level. It is impossible, however, to determine the probable height in advance, because the composition of sheet rubber varies,

Launching Ballon-Sonde.

and the rubber is full of minute pores which open out as the balloon rises and let the gas escape. A balloon such as is shown in the photograph takes with it a parachute weighing about a pound, a small recording instrument of about the same weight, and a basket weighing about a quarter of a pound. The parachute closely resembles the larger ones employed by parachute jumpers. It is about two yards in diameter and is made of thin muslin, which conforms to the shape of the balloon. The parachute is not absolutely necessary for the safe descent of the instrument, for the remains of the balloon drift down quite gently. In the case of a heavy instrument sent up, two balloons are sometimes employed, one of which is distended so that it will burst, while the other, partially filled, serves as a parachute. The instruments sent up include the baro-thermograph recorders as improved by Teisserenc de Bort, and the baro-thermohygrograph.

The digest of the Blue Hill observations contributes a number of valuable and suggestive data, embracing the temperature gradients at successive heights, and the relative humidity in different parts of cyclones and anticyclones. Facts of extreme interest disclosed by the results are that at the earth's surface the coldest portion of an anticyclone is south-east of the centre, and the reverse is true of the cyclone. "At each successive rise of a mile and a quarter the position of the area of cold in the anticyclone and the position of the area of warmth in the cyclone shifts northward in a semi-circular course around the centres of the anticyclones and cyclones, till at six miles high the area of cold has gone to the northern portion of the anticyclone and the area of warmth is in the north-eastern portion of the cyclone."

Advances in Tropical Medicine.

As a supplement to the Report of the Wellcome Research Laboratories of the Gordon Memorial College, Khartum, Dr. Andrew Balfour, the Director of the Laboratories, and Dr. R. G. Archibald, have compiled a review of recent advances in Tropical Medicine. This work, which contains material of the highest usefulness, has been published for the Soudan Education Department by Messrs. Baillière, Tindall, and Cox, who are responsible for the publication of the biennial reports of the Wellcome Laboratories. It does not lend itself to sumptuousness of illustration, such as is so marked a feature of the volume reviewed in the April number of "KNOWLEDGE," and which only finds a parallel in some of the publications of the richer institutions of the United States; but its printing and arrangement and complete absence of errors reflect the highest credit on the publishers. We pay this tribute no less readily because we are greatly indebted to Messrs. Baillière, Tindall, and Cox for the assistance they lent us in preparing illustrations for the review of the work of the Laboratories.

In a prefatory note, Dr. Balfour states that the range of subjects is limited because, though the compilation is intended to serve chiefly the needs of those workers in tropical countries to whom the difficulties in keeping in touch with current literature are considerable, yet the volume is intended to be supplementary to the Third Report of the Wellcome Research Laboratories, and so deals principally with work in which those Laboratories have borne their share. Inasmuch as some sixty diseases are dealt with, ranging from Ankylostomiasis to Yellow Fever, and from Sleeping Sickness to Influenza, the range is nevertheless considerable, and we may point especially to the assemblage of digests of research in Sleeping Sickness as an example of the value of the work. Nothing except constant labour and a systematised card index can enable a bacteriological laboratory to keep in touch with all the investigations that are made;

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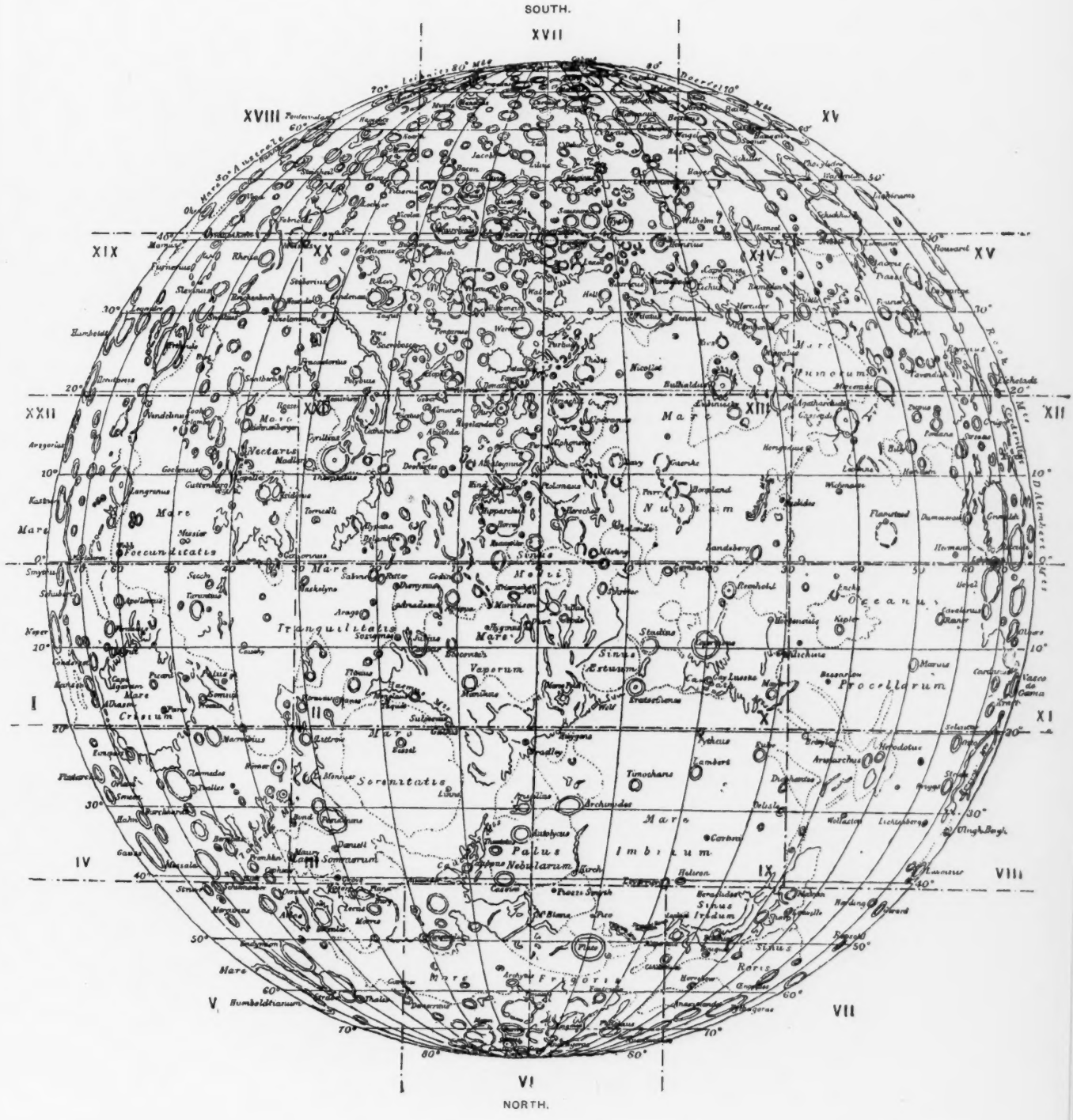
but Drs. Balfour and Archibald have done an amount of indexing and summarising in this volume which moves one to amazement at their industry, and which only those who attempt to keep in touch with the literature of bacteriology can estimate or even appreciate.

Native Charms used in the Soudan.

We reproduce a drawing, for which we had not space last month, from the Report of the Laboratories. It represents some of the charms which are still used in the Soudan by the natives as preventives against sickness. The stones at the top of the page are used, one as a charm against horse sickness, the others, including the necklace, serve either as preventives of headache or sunstroke, or perhaps to bring luck. The little horn on the right prevents wounds; the small book is a written charm. The coin is a silver charm which children wear to protect them from the Evil Eye; and on its silver rim run the words "Protector, Protector, protect our little Ali from Evil." The two charms to the right at the bottom of the plate are also for children; the one in the middle protects both horse and rider from ill luck on the road.



A Plan of the Moon, Showing its Principal Features.

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Erroneous Photographs of Lightning Flashes.

By WILLIAM J. S. LOCKYER, M.A., Ph.D., F.R.A.S.

IN some previous numbers of this journal I have drawn attention to the study of lightning discharges by means of fixed and moving cameras, and have described and illustrated many of the peculiar features displayed on the photographic plate when instruments in good adjustment have been employed.

It was pointed out for instance that the photographs which were supposed to be records of "beaded" or "pearl" lightning flashes were really records of the trails of alternating electric street lamps. It was also shown that many peculiar features of lightning discharges which have been indicated on photographs were due to the fact that the camera during exposure was not kept quite still.

It often happens, however, that some actual flashes of lightning which have been secured on the photographic plate are erroneously described to be special kinds of electric discharges, while in reality their curious appearances are caused by an indifferent lens or a maladjustment of the camera.

Again, many who attempt to secure photographs of lightning obtain on their plates strange, weird-looking trails which they consider are undoubtedly forms of lightning or the effects of it. Such markings, on closer examination by one who is familiar with the many possible sources of error that may arise, are at once detected to display no record of lightning flashes, and, in fact, to have no connection at all with such phenomena.

It may therefore not be without interest to bring together one or two of the different varieties of error which commonly occur. Such information may serve to help those who have taken, or are about to take, up this fascinating branch of photography, and they will then be in a position to guard themselves against them, and possibly assist others in translating correctly what has been recorded on the photographic plate.

These anomalous forms may be divided mainly into two classes, namely, those due to (1) the instrument employed and (2) exposure of camera to bright objects other than lightning flashes.

Let us take the case of the camera first.

Every one is familiar with a photograph of some object which has been taken when the focus of the camera was not properly adjusted; everything is blurred.

Now a picture is really made up of a multitude of *points*, and if a photographic plate be placed in the focal plane of the lens a sharp negative is the result, that is, there is a corresponding point on the plate to each point in the subject. If, however, the plate be moved even a little to either side of the focal plane each point in the subject becomes a small disc. Anyone can try this for himself by racking a camera in or out of focus when the image of a distant lamp or star is allowed to fall on the ground glass.

The result of this in a landscape is that the picture appears blurred, due to the innumerable overlapping discs.

We may consider an ordinary flash of lightning as made up of a series of very close points of light, and if the camera be set correctly in focus the images of these points will be so very near together that we shall produce a sharp continuous line. On the other hand, if the camera be out of focus the line will still be continuous but broad and of less intensity.

We know that a flash of lightning seldom, if ever, takes an absolutely straight course from cloud to earth, but deviates more or less either to the right or left or towards or away from the observer.

An out-of-focus photograph of such a flash will not, therefore, be a continuous broad streak made up of overlapping discs of equal intensity throughout its length, but it will be brighter in those parts of the path where the flash is either coming towards or receding from the camera.

On numerous occasions such photographs of lightning flashes have been secured, and they have been looked upon as instances of a new form of lightning. In some cases they have been termed "rope" lightning, because the overlapping discs gave the appearance of rope; in other cases the photographs have been stated to illustrate the curious phenomenon of "ball" lightning, as the overlapping discs resembled different images of a sphere.

The reader will be able to see for himself some of these photographs, which are here reproduced. Thus figure 1 shows a flash which was taken during a storm in 1900. In this case the photographer in a communication to me wrote: "I have taken the liberty to send you a photo. of a flash of lightning taken by myself last year. . . . Could you account for spots and rings? I can vouch for the photograph being genuine. I have never seen anything like it before; the only approach to it I have seen is the photo. of a spark from a Wimhurst machine."

In answer to a letter I wrote him stating the above-mentioned "out of focus" explanation, he replied: "Thanks very much for your explanation of lightning photo., which tallies very much with the conditions under which the photo. was taken, for I had to judge the focus, &c."

Another instance similar to the above may be mentioned. The photograph was taken near Gloucester on June 29, 1901. The photographer was also astonished at the appearance of the flash he photographed, for in his letter he wrote: "The flashes seem of unusual breadth; the storm was about $1\frac{3}{4}$ miles distant." That the camera was out of focus may be judged from his postscript, which was as follows: "The hill (out of focus) in the background is Robinswood Hill, near Gloucester."

The next example is of special interest, as the photographer does not agree to the out-of-focus explanation being applied to the flash he secured. The camera used was a $6\frac{1}{2}$ by $8\frac{1}{2}$, with a Zeiss anastigmat.

In reply to a communication suggesting that the peculiarity of the flash in No. 2 photograph probably lay in the camera being slightly out of focus, he wrote:—

"No. 2 is emphatically *not* out of focus. The original negative is beautifully clear cut, and can be examined with a magnifier up to a high power. The print is not good, because the negative is slightly fogged and dense, making it a very slow printer. In making these photos. I have focussed by daylight on an object two or three miles away, and kept the focus. One of my flashes was taken in a hurry, and I had to focus after dark; the result is utterly different from No. 2. Of course, you understand that the lens was not in focus for any object either near or far. It is very clear that No. 2 was not out of focus, for the convolutions (rope-like appearance) are so fine and clear; whereas, if they had been out of focus, they would have been greatly dimmed. I have shown the original negative to a number of photographers, and all are unanimous in the view that it is in good focus. I am not fully satisfied as yet as to the effect of the lens. I have made photographs of electric sparks 18 inches long, and they have shown the same clear cut lines as a simpler lens shows, so I am pretty well satisfied that the lens is

not responsible for the broadening. I have also taken a good many flashes; in fact, all but three or four which do not show any such broadening."

It will be seen that the main argument of the writer of the above letter in favour of the flash not being out of focus is that "the convolutions are so fine and clear." If the reader will glance at figure 1, it will be seen here also that the convolutions are equally fine and clear, but yet the landscape distinctly shows that the camera was not in good focus for distant objects.

So often is this "out of focus" effect of a lightning flash described as being due to the peculiarity of the discharges themselves that another instance may be cited in order to show the reader how common this error is, and how careful he must be in interpreting the photographic records. The photograph to which reference is made was taken at Addlestone on May 31, 1903, and the flashes are described as being very different from the usual photographs of lightning. The account which accompanies this photograph states: "The camera was placed at a height of 35 feet from the ground, facing east, and the two flashes were almost instantaneous. The distance was only about 200 to 300 yards, so that there is more detail

Fig. 1.—Photograph of a lightning flash with a camera out of focus, showing the overlapping discs giving the flash a "ropy" appearance. Notice the church tower out of focus.

than usual in the negative. A careful study of the latter leads to the conclusion that the luminous body must have been globular. In the upper flash, two circles will be seen, which are apparently the end views of two zigzags towards the camera; the short intervening space, being much lighter, shows that the flash had partly reversed its direction before the second zigzag took place. In the lower flash a similar circle may be seen, and it will be noticed that all the deviations from the main lines of the flashes are curves, corresponding with the outer curves of the globes. It seems highly probable that these luminous globes were in rapid rotation during their passage through the air."

From the above account, it will be gathered that the photographer in no way questioned the record he secured, but simply assumed that the object was properly photographed, and described the result as the trail of luminous globes! In this photograph we are dealing, it seems unnecessary to state, with images of lightning flashes very much out of focus.

Another source of instrumental error that renders flashes peculiar in their appearance is that caused either by the lens not covering sufficiently well the plate employed, or the photographic plate being inclined to the focal plane of the lens. Everyone is familiar with the want of definition in the first case, the pictures obtained decreasing in sharpness the greater the distance from the centre of the plate. In the second case the definition becomes bad the further the plate is from the focal plane. In the photography of lightning flashes cases often occur when the flash for the main part of its length is clear and sharp, while towards the edge of the plate it becomes broad, and has a rope-like appearance, as previously described. An instance of this kind is shown in figure 2.

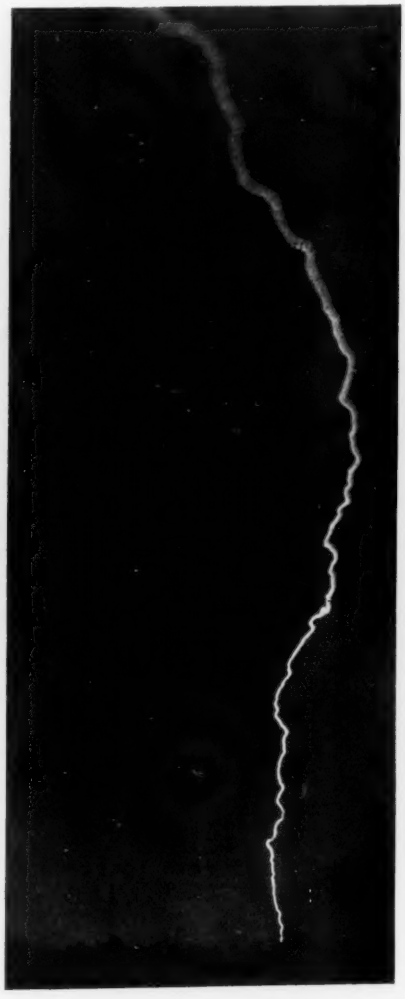

Fig 2.—A flash of lightning photographed with the plate oblique to the focal plane of the lens. Notice the out-of-focus appearance of the flash at the top.

The rope-like appearance in the upper portion of the photograph and the clear sharp part of the flash in the lower part show undoubtedly some source of instrumental deficiency, most probably the inclination of the plate to the focal plane. In this case also the photographer does not agree with this explanation, for he wrote: "I cannot accept your views as to my flashes. The long one could not have had any portion out of focus for in these lenses everything beyond 100 or 200 feet is in good focus. I have thought that if there had been a slight change in intensity coupled with a slight dimming

at the centre and an apparent spreading out of the light through mist or fog (cloud) the appearance of the photograph would be explained. I think this flash quite remarkable, and apparently decidedly negatives the view that the broadening is due to the anastigmat lens, as I feared when I took the other photograph might be the case."

It appears to me that "bad definition" seems far more simple and rational an explanation than the "apparent spreading" caused by the mist or cloud, and the fact that "everything beyond 100 or 200 feet," in the lens he employed, is in focus would not be the case if the plate were inclined to the focal plane. As a matter of fact, cloud does not apparently broaden a flash, but either completely obliterates it or renders it more faint. In this connection it is interesting to look at the flash illustrated in figure 3, where the flash occurs behind several portions of thick and thin clouds, and in no place is it

Fig. 3.—Lightning flash partially behind clouds showing that cloud simply diminishes the intensity of the flash or completely obliterates it. Taken by H. B. Lefroy, in Canada, June 6, 1896.

broadened thereby. This illustration affords an excellent example, because the ramified lightning flash occurred beyond some fracto-cumuli, so that various thicknesses of cloud are situated between the camera and the discharge. The photograph was taken by Mr. H. B. Lefroy in Canada on June 6, 1896. Other examples could easily be given to show that the presence of cloud in the line of sight of a lightning flash either diminishes its intensity or completely eclipses it.

We come now to the second class of anomalous forms due to the photographic plate being exposed unintentionally to bright objects other than lightning flashes.

Suppose, for instance, that a thunderstorm is taking place at night and lightning flashes are darting about. A camera is put out on the window-sill and the plate left exposing. A storm being only of a transitory nature it is quite likely that the clouds will clear away, and if there be a moon, she will become visible in the sky. Unless the photographer closes his camera immediately the storm is over, it is quite natural that any bright object that falls in the field of view of his camera will be recorded on the photographic plate.

On the development of the plate he may find that some strange streak appears, and he may be led to believe that it represents a peculiar lightning flash. Let us take a case which has actually happened when the trail of the moon was photographed unintentionally. Unfortunately, I am not able to reproduce the original photograph, but I have repeated the experiment when the moon was in a convenient position, in order that the reader may familiarize himself with the kind of streak that is obtained. The actual operation was to expose a plate in a 5 × 4 Kodak for half-an-hour to the moon, which was three-quarters full; then, without capping the lens, to pick the camera up and move it about for two or three seconds with the image of the moon still falling on the plate, finally putting on the cap. Unbacked plates were used so that halation is somewhat strong.

On two different occasions plates were exposed in this manner, and one of these is reproduced in figure 4. In

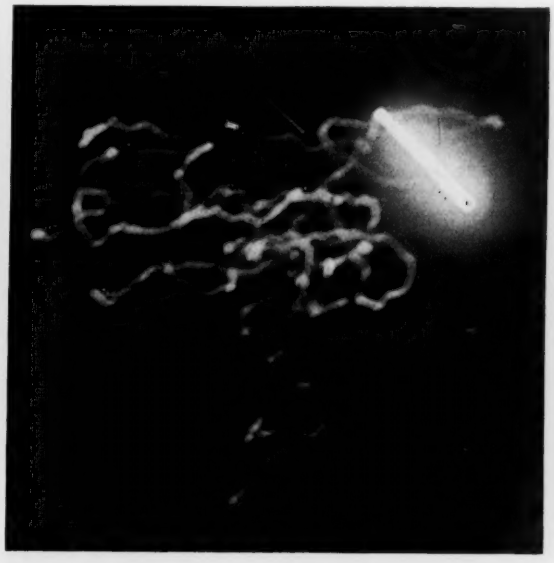

Fig. 4.—Photograph showing the natural trail of the Moon and the planet Jupiter, and the trail of the former due to camera movement. Taken by W. J. S. Lockyer on January 7, 1906, 2.30 a.m.

this (taken on January 7, 1906, 2.30 a.m.) the straight moon trail is broken at its upper end; this was done intentionally as I desired to secure a small image of the moon by itself. In this figure the fine straight line is the trail of the planet Jupiter, which was in close proximity to the moon at the time. It is interesting to remark here that when the camera was moved at the end of the exposure the light of Jupiter was not sufficiently intense to produce a trail of its own.

The reader will probably be struck with the close resemblance of this wavy trail with those of lightning flashes taken out of focus. The similarity is indeed strong, and in fact this ought to be the case, for just as the out-of-focus flash was made up of a series of discs, so the moon trail in these cases is composed of a series of over-lapping three-quarter moons; if the moon had been full, the resemblance might have been closer still. In the moon's trail there are also bright parts due to the slower movement of the camera at these points; these are the equivalent to the bright portions of the out-of-focus

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lightning flash when the latter is moving towards or away from the observer.

When taking photographs of lightning flashes at night care must be taken to expose the plate only when the camera has been rigidly fixed on the window-sill or whatever support may be chosen. After the exposure has been made it is important also to replace the cap or close the shutter before the camera is in any way moved. If such precautions are not adopted it is quite possible to find, on development of the plates, numerous streaks which the photographer may think are peculiar lightning flashes, but which are due to quite a different cause.

In these days the means employed for lighting streets are so good and photographic plates are so sensitive that the photographer must be very careful not to expose his plate, even accidentally, to such sources of light during the operation of photographing lightning. If his camera be fixed and so oriented and exposed that such artificial lights fall in the field of view, he will find them recorded on his photographic plate. Should, however, the camera be accidentally or purposely moved while the plate is being exposed, each point of light will leave a trail on the photographic plate. When photographing lightning flashes at night it is, therefore, very important to bear these facts in mind, otherwise in deciphering the trails recorded false impressions may give rise to erroneous deductions.

In order to familiarise the reader with the appearance of such artificial light trails the accompanying illustration (fig. 5) is inserted. This photograph was taken with the camera held in my hand and moved about while the plate was being exposed. The trails photographed were those produced by the electric arc lamps opposite Buckingham Palace, the brighter and fainter streaks representing the nearer and more distant lamps respectively. As the current supplying the lamps was "continuous" the streaks are continuous, but if the current had been an alternating one the trails would have had a, dotted appearance. (See "KNOWLEDGE," July, 1907, p. 146). The form of the trails depends, of course, on how the camera is moved, the smaller the movement of the camera the shorter the trail. A great number of instances with which I am acquainted have occurred in which artificial trails, such as the above, have been secured, and put down to the peculiarity of lightning.

Fig. 5.—Trails of electric arc lamps (continuous current system) opposite Buckingham Palace, showing nature of markings recorded. Taken by W. J. S. Lockyer.

One such case is that illustrated in the accompanying figure (fig. 6) which represents the result of exposing a plate during a thunderstorm at Margate some years ago. In describing this photograph, the operator stated:

Fig. 6.—Supposed lightning flashes which are actually the trails of street lamps (at Margate) due to camera movement.

"Obviously it is the same flash repeated at regularly decreasing intervals. I suppose it must be reflections from the lens, but, if so, why does that occur in this case and not when taking, say, a brightly, sunlighted object or a window."

A close examination of this photograph shows that the series of streaks, of diminishing intensity from right to left, have each a trail extending to the bottom of the figure, showing that in this case gas or electric lamps were their possible origin. If street lamps were the cause, then their different distances would explain the diminishing intensities, and a camera movement would account for the forms being similar.

In order to become acquainted so far as possible with the actual conditions under which the photograph was secured, inquiries were made through a mutual friend. I suggested also that the camera should be exposed again if possible under similar conditions (excepting the thunderstorm). In reply to my questions, my informant has found out that there were street lamps in the field of view of the lens, and he further states: "My correspondent writes me that he has made an experiment with an ordinary street lamp—exposure 2 to 3 seconds—moving the camera slightly. The result clearly proves to him that your theory is correct."

Another and last example may be cited to illustrate the pitfalls the photographer may fall into unless he closely examines the markings on his plates and the conditions under which the exposures were made.

Some years ago, during a thunderstorm which occurred at Dover during the night, a photographer exposed numerous plates in order to record the lightning flashes. In the field of view of his camera were one or more electric arc lamps and festoons of smaller glow lights from standard to standard, with occasional cross festoons over the roadway, which naturally produced a charming effect at night.

On development of his plates he found that whether or not the picture took in a flash, and in most cases this did not happen, he found exhibited on them the light of the permanent lamps, and *that from them a flow of electricity proceeded towards the ground* in an irregular line. He found further that summer or sheet lightning produced the same effect upon the lamps, but, when neither was present, an exposed film only showed a sequence of white dots or perpendicular short strokes in the places occupied by the lamps.

The examination of the negatives gave the photographer the first impression that the electric discharges in the heavens produced an instantaneous one also from the lamps, and that in this way the circuit was completed,

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but he suggested that other causes beyond these must have been in action from the disjointed and irregular display from the lamps as opposed to that of the lightning.

There is, however, no doubt that he considered the trails as due to the flow of electricity, for he stated that he noticed with the unaided eye on one occasion a stream of electricity descending from an arc lamp towards the earth, which, as he says, he should assuredly have never seen had he not learnt from his photographs that such a phenomenon did exist. Turning our attention now to the photographs he secured, the reader can see for himself the kind of markings which were recorded. There do appear some lightning flashes, but all the other markings on the plate are the trails resulting from the movements of the images of the arc lights and smaller electric lights on the photographic plate, caused by a movement of the camera. Further, one can say with certainty that the current supplying the lamps was alternating, because the individual trails in most cases are "beaded" or "dotted" and not continuous lines. Where they are continuous it is evident that the movement of the camera was not sufficiently fast to separate the individual dots in a trail.

Without dwelling further on this particular example, which gave rise to the consideration of the question of the effect of lightning discharges on electric lamps, sufficient perhaps has been written to indicate to the reader some of the sources of erroneous lightning flashes.

Those who wish to make themselves better acquainted with the peculiarities of the photographic trails of different light sources cannot do better than reproduce them for themselves, and in this way they will soon be able to differentiate between photographs of real and spurious lightning discharges.

The Greenhouse Theory and its Application to the Case of the Atmosphere.

To the Editors of "KNOWLEDGE & SCIENTIFIC NEWS."

SIRS,—In your March number Professor Porter, noticing some experiments by Professor R. W. Woods, speaks of "the generally accepted theory" of the mode in which a greenhouse warms up under the action of the sun's rays by selective absorption. But surely that theory was not generally accepted. Meteorologists, as a rule, liked it because it looked so simple, and because they thought that there was a complete analogy between the greenhouse and the atmosphere. Physicists, perhaps, were not quite so confident either about the greenhouse theory or its application to the conditions of the atmosphere. Eleven years ago Dr. A. H. Fison pointed out that in the case of the greenhouse, probably the prevention of the circulation of the enclosed air by the glass is partly responsible for the rise in temperature.

With regard to the selective absorption of heat by carbon-dioxide, or water vapour, or what not, which have been suggested as responsible for the storing up of enormous quantities of heat in the atmosphere of Mars, and of the earth in past ages, the greenhouse theory analogy seems to break down, because the higher the temperature of the lower air, the greater must be the vigour of its upward movement. My own idea is that so far as the atmosphere is concerned its temperature depends upon the relation between the relative and absolute humidity; solar radiation being absorbed at a rate that depends upon the absolute humidity, while terrestrial radiation depends upon the relative humidity.

Believe me, yours, etc.,

J. R. SUTTON.

Kimberley,
March 31, 1909.

The Peruvian Warrior.

By OSWALD H. EVANS, F.G.S.

AMONG the many thousands of readers who have passed delightful hours over the now classic pages of Prescott's "Conquest of Peru," it is probable that comparatively few have succeeded in conjuring up a clear mental picture of the warriors through whose dense ranks the steel-clad Spanish adventurers followed Pizzaro to the sack of the most wonderful civilisation ever attained by the peoples of the New World. In the days when Prescott penned his ever-admirable volumes, Peru was practically unknown ground to the archæologist. The spade and pick of the treasure-seeker, ever the destructive forerunner of the scientific explorer, had alone disturbed the mounds of crumbling *adobé* covering ruined cities or trenched the sands of forgotten burial-places. There were few who knew more intimately than Prescott the Spaniard of the sixteenth century, not only in his heroisms and failings, but in the details of his daily life in peace and war; but for information as to the manners and customs of the native Mexicans and Peruvians he had perforce to rely entirely on the records of the Spanish writers who are still, it must be confessed, our main authorities on the subject. Of South America it may still truly be said that, from the archæological point of view, "the harvest is great, but the labourers are few."

The enthusiastic student of Peruvian antiquities is very apt to forget that his favourite subject has not been widely popularised, and is only too liable to assume that his readers have an acquaintance with the matter which, in the nature of things, they are scarcely likely to possess. The well-informed may therefore pardon a word of explanation necessary for the clear understanding of the remarks which follow.

Thanks, possibly, to recollections of "The Conquest of Peru," the term "Inca" is generally taken to cover every class of antiquity derived from North-Western South America, the "Peru" of Spanish Colonial times. It comes as a surprise to many to learn that objects to which such a description can reasonably be applied are comparatively rare. By the uncritical writers of the Conquest, the term "Inca" was used to include nearly all the varied peoples, arts, and institutions with which they or their immediate predecessors came into such disastrous contact, and it is only of late years that we are beginning to appreciate how great a diversity of race and culture this convenient designation has been made to cover.

Long ago the fact was pointed out by Squier that the majority of the articles in museums and private collections so freely labelled "Inca" or "Peruvian" have been actually derived from a comparatively limited area on the Peruvian coast, the site of former populous towns of the so-called Chimu people, with whom the Incas appear to have waged protracted but ultimately successful war—"or ever the wild time coined itself into Calendar months and days." The Chimu nation, combining industry with luxury and art, produced some of the most beautiful textiles ever woven, developed an interesting metal-craft, and, above all, fabricated pottery that would not disgrace the Mediterranean region. A certain class of this earthenware is adorned with delightful pictures, usually drawn in a dark brown pigment upon a buff-coloured ground, representing scenes from the life of this remote and now vanished race. I consider that there is evidence to show that the Chimus exercised considerable influence on the arts, and probably on the manners, of their neighbours, and that we may, therefore, safely illustrate and supplement the scanty

information supplied by the early Spanish historians by reference to these remarkable vase paintings.

The drawing of the figures is excellent. In the scenes from common life no attempt is made to add dignity to chiefs and warriors by means of those conventionalised representations of feather head-dresses and doubtful attributes which reduce Mexican and Maya carvings to a mass of intricate and wearying confusion. Details of the vase paintings can occasionally be confirmed or elucidated by reference to pottery figures executed in the "round," full of vivacity and expression, even when serving merely as the body of a jug; a jug, moreover, constructed in such manner that it whistles when liquid is poured in or out of it! So realistic is the portraiture, and so evident the artist's gaiety of intention, as instanced, for example, in a British Museum specimen representing the face of a man in a state of intoxication, that one can scarce refrain from quoting Omar, and speculating on the possible consequences of filling the vessel with "the old, familiar juice" of *chicha*. If it be true, as some maintain, that pottery of such vivacity was destined only to add dignity to the tomb, we must look as far afield as Etruria for a parallel practice.

Notwithstanding the fact that our knowledge concerning the martial equipment of the true "Inca" soldier is largely derived from the statements of men who gained their information at first hand, singularly enough, we can speak with much greater assurance and with fuller detail of the aspect presented by the warrior of Chimu; for in the latter case so much more archæological information is available. Over all the narratives of the "Conquistadors" there hangs a certain shade of doubt arising from their manifest tendency to explain novel experiences in terms of European equivalents. It is not intended to depreciate the value of the early histories in the least, for in style, interest, and evident conscientiousness of intention they challenge comparison with any documents of the kind in existence; in the present instance, however, they speak vaguely of the arms of Atahualpa's soldiers as "pikes, halberds, lances, and clubs of silver, gold, and copper," and dismiss their military tactics in the simple summary of "*muy belicosa y muy diestra*."

A glance at the illustrations which accompany the present article will reveal a remarkable confirmation of the little information on such matters that the Spanish writers have handed down to us. Figures taken from different vases confirm one another in detail. Beginning with weapons of offence, it will be seen that the Chimu man-at-arms favoured a massive club with a head of uncertain material but probably of bronze or copper, such "*casse-têtes*" being formerly so commonly found in the ruins of the coast towns as to be sold "by the ton," according to Squier. They were wielded with both hands, and warriors armed with this formidable weapon are usually represented without shields. The double-handed club was called *Macana*. The truculent little figure sketched from a statuette in a private collection in Lima, but almost identical with an example in the British Museum, is armed with a short, single-handed mace and small buckler. The head of this club resembles the circular perforated stones, supposed to be either club-heads or weights for "digging-sticks," which are commonly found all over Western South America, or the "star-stones" brought by Mr. Whymper from Ecuador.

An armed and winged divinity, represented in flight on a vessel now in the British Museum, bears a small circular buckler with a bundle of javelins and a spear-thrower of the rigid type, the latter being an object not often represented. In the other hand he bears the heavy, double-handed mace *Macana*.

Garcilasso de la Vega, a descendant of the Incas, mentions, among other weapons, a spear called *Chuqui*, big two-handed axes, and a smaller axe, *Champi*, a cubit long, having a blade on the one side and a sharp point on the other. Arms and other military equipment formed no inconsiderable part of the provincial taxes under the

Inca system, each province supplying that material which it produced in the greatest abundance. Bows and arrows were used, the latter having bronze or copper heads of square section, although it is probable that for this purpose metal had not entirely ousted stone. In the desperate siege of Cuzco, the insurgent Indians fired the town

again and again by means of flaming arrows or balls of combustibles hurled from slings. Speaking of slings, Don Alonso Enriquez de Guzman says that these primitive weapons "carried with the force of an arquebus;" he saw a sword broken in a man's hand at a distance of thirty paces. A characteristic South American weapon

was the three-balled bolas, called *Ayllus*, which entangled the limbs, bringing the victim instantly to the ground.

The Chimu vase-paintings represent a beardless race with long hair, which was apparently worn elaborately braided and decorated. From the ears of the figures depend the massive circular ornaments which earned the Peruvians the nickname of *Orejones* from the Spaniards. These massive discs were sometimes inserted in enlargements of the ear-lobes, as in trans-Andine Peru to-day; but in pottery examples they are often shown suspended from smaller rings without the extraordinary deformation.

The warriors' faces are painted—a feature mentioned by Miguel Balboa. Especially striking is the high conical helmet worn by many of the figures, which is surmounted by a peculiar crescent-shaped ornament of gilded metal. Several examples of this ornament or badge are to be found in Museums, where they are generally labelled "knives" or, more mysteriously, "objects." Personages of presumably high rank are represented wearing elaborate head-dresses adorned with animal-heads, strikingly recalling classical models. In the ancient Peruvian drama "Ollanta," the Inca bestows

a head-dress upon a chieftain when appointing him to the chief command in the army, and Garcilasso tells us that the diverse tribes which swelled the Inca's hosts with fighting men were distinguished by the form of their head coverings.

The angular outline of the dresses worn by some of the figures suggests armour, and it is known that quilted cotton was made use of for this purpose, forming an admirable protection from the blows of blunt weapons and from the flights of stone-headed arrows launched by the foemen of lower culture with whom this early civilisation had to contend. The Spaniards themselves were glad to adopt armour of this character in their West Indian possessions to ward off the poisoned arrows of the unsubdued barbarians. One is tempted to read some heraldic significance into the complicated and fantastic designs covering the clothing of these gallant men-at-arms.

A curious object will be noticed depending from the decorated belts which encircle the waists of the Indian soldiers. It does not appear to be a shield, and may very possibly be a kind of pouch for provisions. I am inclined to consider, from its peculiar shape, that it was designed to hold permanently an earthenware water-vessel of the well-known elongated type, its long neck being preserved from accidental injury by a packing of the maize meal which formed the common article of food. Water would have to be carried somehow in a desert campaign such as the vase paintings depict, where the fight rages among clumps of cactus. A broad wrist-guard and, in some instances, sandals which leave the toes free complete the warlike equipment.

Assuming that the defenders of the coast and sierra were at least as well armed when Pizarro's desperate adventurers landed, it seems more wonderful than ever that such a handful of Europeans should have been able

to crown their foolhardy enterprise with complete success. Exhaustion at the close of a protracted civil war, Superstition, and Destiny alone suggest some imperfect answer to the problem.

That the Indians lacked not valour was abundantly proved in the insurrection that broke out ere the invaders had made good their hold of the country, when Cuzco all but fell; that they possessed military capacity, the ready adoption of European arms and horses and their rapid development of new tactics to meet the changed

conditions sufficiently demonstrate. In these matters the Indian of South America has shown himself superior to his more famous fellow of the Northern Continent. At a later date, Lopez Vaz tells of the Araucanians of Chile that "in times past their halbard and pike heads were of brasse, but now they have gotten store of yron. They pitch their battels in maner like the Christians, for putting their pikemen in rankes, they place bowmen among them, and marshall their troupes with discretion and great valour."

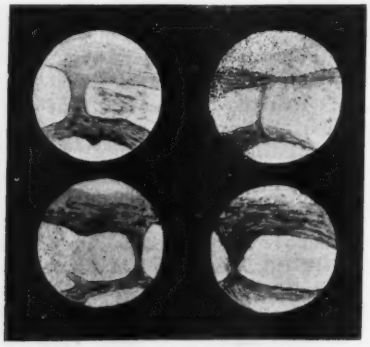
XUM

What a Very Small Telescope Will Do.

By ARTHUR MEE.

WE live in the day of great telescopes, yet although this is the case, the number who are privileged to use them is necessarily very limited, while the beginner is too often discouraged by the false idea that, after all, the heavens only reveal their beauty to the users of great instruments. As this undoubtedly deters numbers from taking up observational astronomy, I have put together these notes with a view of showing that very small telescopes, *if good*, are capable of revealing many interesting features and even of doing useful work.

A 3-inch telescope is generally considered the smallest size that is of any use in astronomy, but there is ample evidence that even a 2-inch will do a great deal, provided it be of good quality and furnished with a really steady stand. Probably the stand is the weak point with many small telescopes. Large ones are usually mounted in a steady manner, and if a 2-inch is to do its



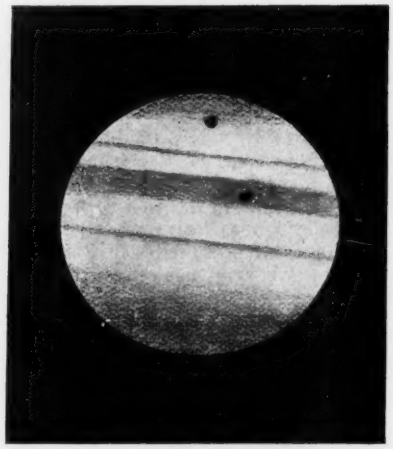
Mars—1866-7.

(Drawn with 2-inch achromatic. Exactly reproduced from Mr. Grover's observation book.)

utmost it must be at least as fairly treated in this respect as its big brother. How often is this the case?

Let us glance rapidly at a few celestial objects and see what a very small telescope will show. I will pass over the great field of stars and nebulæ with only a word, because in these regions aperture is almost a necessity. Still, even here, a small instrument will do something if intelligently used. We have the authority of Webb that Castor has been seen double with aperture reduced to three-quarters of an inch; whilst Mr. Gore has seen four stars in the Trapezium with 1½-inch. Gamma Leonis has been split with the same aperture. Dr. Kitchener saw Rigel double with 1⅜-inch—an undoubtedly noteworthy achievement. Probably the beginner would be hardly so successful with very small aperture, and he would always have to keep his imagination in check. Still, these records show what a very small glass can do in good weather; whilst, of course, to merely sweep among the star fields will be a work of unending interest.

Coming now to the solar system, there are various objects which can be almost entirely ruled out. Amongst these are the Planetoids, though some of them were discovered with small telescopes and the larger ones may be followed by such apertures as those under review. The Rev. S. J. Johnson—than whom few knew better how to employ a very small telescope to all-round advantage—saw Vesta emerge from occultation with a power of 70 on a 2¼-inch. The outer planets, Uranus and Neptune, can be easily followed with a 2-inch, and it is satisfactory to know that they

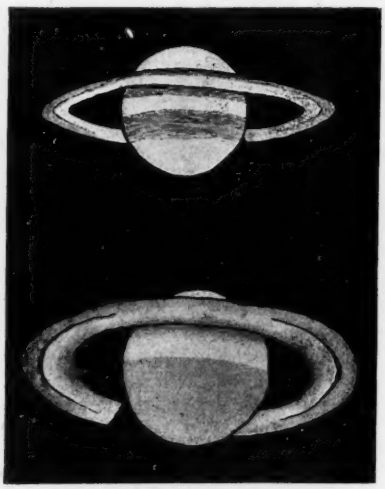


Jupiter and satelite-shadows in transit—Oct. 12, 1904.

(Drawn with 2-inch Wray by T. K. Jenkins, Blaina.)

are not wholly beyond our ken at the distance of 1,800 and 3,000 million miles respectively!

Mars is a deeply interesting object, but admittedly difficult for very small apertures. It takes a good telescope to bring out his delicate markings in perfection.



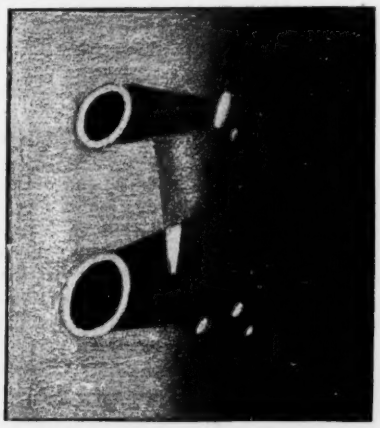
Saturn—1865, May, and 1866, Jan.

(Drawn with 2-inch achromatic. Exactly reproduced from Mr. Grover's observation book.)

Still, the larger features—the polar snow and the main outlines of the "continents"—are not entirely beyond our reach. A spot has been seen on Mars with only 1½-inch, and Johnson tells us how astonished he was after viewing the planet with a 4-inch achromatic to see how pluckily a smaller instrument dealt with it. "Everything that could be seen with 4-inch could be

distinctly traced with 2¼-inch, only smaller and a little fainter."

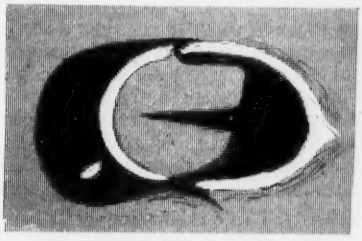
But the most remarkable testimony to what a first-rate 2-inch achromatic will reveal on Mars is afforded by Mr. Charles Grover, of Rousdon. Some years ago that veteran astronomer placed in my hands his old observing book, containing drawings of the planets made in the sixties with the above small aperture. The Mars designs exhibit the main features of the planet in a masterly manner, and there are larger telescopes which would reveal no more detail than Mr. Grover's keen eye was enabled to catch. Of



Lunar Craters—Diophantus and Delisle.
(Drawn with 2-inch Wray by T. K. Jenkins.)

course, Mars must be favourably situated for such work to be done with such very feeble optical means, but no doubt it will surprise many readers that it can be done at all!

Compared with the objects we have been considering, Jupiter is very easy. He has an expansive disc which a power of only 40 renders as large as the naked eye moon, whilst his four largest satellites are strikingly

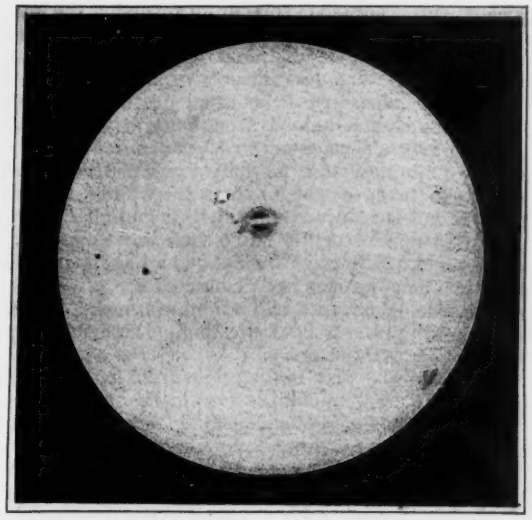


Lunar Walled-plain—Plato—Feb. 17, 1866.
(Drawn by Mr. Grover with 2-inch achromatic.)

apparent in a 2-inch, and one or two of them are said to have been even glimpsed without any instrument. As Mr. T. K. Jenkins, a Welsh working-man astronomer, has lately shown, a 2-inch is capable of giving clear views of the belts and of the shadow-transits of the satellites. The colours of the belts have just been caught with 2¼-inch.

Despite his much greater distance, Saturn is fully as interesting in our little telescope as Jupiter. Turning my 8½-inch Calver, power 60, and a 2-inch Burnerd, power 80, on the planet, I was surprised to find how well the little achromatic stood the test. Of course, with a higher power the Calver would leave the other hopelessly behind. Still, it was evident that the main features were quite within reach of the 2-inch. Many observers could be quoted to show what such an aperture can do with Saturn, but I will merely instance Grover, who saw the belt on the ball, Cassini's division in the ansæ, the dusky tint of the outer ring, the shadow of the ball on the ring, and other features. Of the satellites Titan and, possibly, Japetus are within the scope of the 2-inch, but Proctor's statement that they might at times be caught by an opera-glass should certainly not be taken too literally!

To the possessor of a good 2-inch the Moon will be found an object of perennial interest. As Mr. Holmes says, all except the minuter features are plainly visible, and unless the observer be a very capable artist he will find that he will see more than he can satisfactorily depict. In this connection it is interesting to note that Professor Phillips, after studying the Moon with the great Rosse telescope, passed to a Cooke refractor of



The Sun—July 16, 1905.
(Drawn with a small hand telescope, power 12 and dark cap. Arthur Mee.)

about 2¼-inch aperture—a remarkable transit indeed! Johnson says that with such a telescope he found a power of 200 "very serviceable" on the Moon, but the beginner will probably be satisfied with much lower magnification. Johnson, however, loved deep eyepieces, and was not afraid of 420 on a 4-inch achromatic.

On the Sun the owner of a good 2-inch will find his instrument specially effective, spot-details, faculæ, and the mottling all being beautifully visible with a dark cap. With good air I know nothing more exquisite than the solar surface as viewed with such a telescope, and the observer will find useful work awaiting him if he studies the Sun from day to day and makes careful notes and drawings.

Much more might be said on this subject. The general absence of atmospheric tremor in a small achromatic, and the consequent hardness of the images, are points not to be forgotten; whilst the extreme portability of the instrument is another argument in its favour. Certainly the possessor of a first-rate 2-inch will be loth to part with it when he discovers for himself the extent of its usefulness.

XUM

Photography: Pure and Applied.

By CHAPMAN JONES, F.I.C., F.C.S., &c.

The "Omnicolore" Plate.

In the March number of this Journal I referred to the "omnicolore" plates made by the firm of Jougla, and since then I have had an opportunity of trying them. The first thing that calls for remark is the simplicity of the manipulation of the plate when compared with the procedure recommended for its predecessors. Only three solutions are necessary, namely, the developer, the silver image solvent, and the fixing bath. Indeed, the last appears to be a precaution rather than a necessity, but it has so far been advised for screen colour plates, and it is certainly well to remove as completely as possible all residues of silver compounds. The need for intensification that exists if the best results are desired with autochrome plates is absent in the case of the "omnicolore" plates, for the sensitive layer is a simple gelatine emulsion that gives ample density by mere development. The silver solvent for reversing the image is an acidified solution of potassium bichromate, while an acidified permanganate solution is recommended for autochrome plates. The procedure with the new plate is, after suitable exposure in the usual manner, to develop for five minutes in a metol hydroquinone developer, rinse for twenty seconds, place in the silver dissolving bath for about two minutes, rinse for half a minute, then return the plate to the developer for about three minutes or until the silver salt is reduced to metal, rinse for half a minute, allow it to remain in the fixing bath for three or four minutes, and finally wash for about half an hour. The treatment may be concisely summed up as—develop, reverse, develop, fix, with half a minute's rinsing between each operation and a final washing. I find this simple procedure quite satisfactory.

Comparing the plate with others, it is of interest to note that the predominating colour of the Thames plate screen is green, and its compensating screen attached to the lens is a pure yellow; the predominating colour of the autochrome plates is red, and its compensating screen is orange; and the predominating colour of the omnicolore plate is much redder than the autochrome, and its compensating screen is yellow. Theoretically it would be better to have no predominating colour in the screen but only a neutral gray, for it is obvious that when white light causes the removal of all deposit from the sensitive layer the predominating colour will show, although white, or a neutral tint, would be correct. For good whites neither of these plates must be fully exposed; there must be some silver deposit in the parts that represent every detail of the original. When an autochrome plate frills the sensitive layer comes away and leaves the colours on the glass. An omnicolore plate if caused to frill in cold water will bring the colours off with the film, though hot water easily dissolves off the gelatine emulsion and leaves the colours on the glass.

The omnicolore plates, so far as I have seen them, allow too much white light to pass through the colour screen. The red and green areas are lighter at their margins than in the middles of the patches, and there are many particles of fine sandy or dusty matter in the colour film that appear as white specks on magnification. The green dye is remarkably yellowish, which means of course that it allows red to pass through it. The practical result of this is that a full exposure with a pure red light tends to give an orange instead of a full red colour, and further exposure increases the yellowness of the colour. This effect is not produced on an autochrome plate. But still, whatever possibilities of improvement may remain in the omnicolore plate, it gives fine colours as it is. As to the correctness of the colours it is too early to say much. It cannot be claimed for any colour plate of this kind that it gives of necessity a correct imitation of the colours of the object photographed. The colours depend to a greater or less extent on the treatment of the plate by the user of it, and it would not be surprising if those matters that theoretically appear to be faults should practically prove to be advantageous under certain circumstances when dealing with the mixed and generally sober colours of Nature.

Autochrome Plates.

Now that other plates for photography in natural colours are on the market with instructions for their use that are far simpler than the long series of operations that were prescribed for the development, &c., of autochrome plates, it is only natural that Messrs. Lumière should seek to simplify the procedure necessary for their plates. This they have done, claiming that *only two baths* are necessary, namely, the developer and the reverser. The developer is a quinomet, ammonia formula, quinomet being a compound of metol and hydroquinone. The reverser is a solution of potassium permanganate acidified with sulphuric acid as before. The exposed plate is developed, rinsed, placed in the reverser until the silver image produced by development is dissolved out, rinsed, and returned to the original developer, in full daylight, until the silver bromide is fully reduced to the metallic condition. It will be noticed that there is no final fixing in hypo. Theoretically, perhaps, there should be nothing in the film that hypo. can dissolve out, and as some workers preferred to leave the silver salt after the reversal without the second "development," if there were any silver salt remaining it might not do much harm. But for the sake of permanency it is exceedingly desirable to get out of the film all silver compounds, leaving nothing but the metal, and if this is impossible in an absolute sense it is desirable to get quite as near to this condition as circumstances will permit. To be on the safe side, therefore, I should certainly always give the plate a final soaking in an ordinary fixing bath, and then a thorough washing. If the autochrome plates are now made with a thicker film of sensitive silver salt to render intensification superfluous, then a more prolonged washing than was at first prescribed is necessary. It is a fundamental error to run any risks of leaving silver compounds of any sort whatever in the film.

At the same time that the method recommended for the treatment of autochrome plates has been simplified, the prices of them have been substantially reduced. Quarter plates that were 4s. 6d. are now 3s. for four plates.

International Congress.

The International Congress of Applied Chemistry is held every three years, and this year its meetings will be in London. H.R.H. the Prince of Wales will perform the opening ceremony in the Albert Hall on the 27th of May, and on the following four days its 17 sections and subsections will hold their meetings. Section IX., Photo-chemistry and Photography, will meet under the Presidency of Sir W. de W. Abney, K.C.B., and the Vice-Presidency of Sir H. Trueman Wood. A considerable number of interesting communications have been promised. In connection with the Congress as a whole various social functions and lectures have been arranged. Full details can be obtained from the Honorary General Secretary, Mr. Wm. Macnab, Royal College of Science, South Kensington, London, S.W.

XUM

Asymmetry.

IN Newton's Principia, it is stated, in the discussion of the attraction between a spherical shell and a particle outside it, that the attraction must, *by symmetry*, be along the straight line joining the particle to the centre of the sphere. In this simple case the argument appears to be perfectly sound. There is no reason why the particle should be attracted to one side of the centre of the sphere rather than any other, and therefore it is attracted in a straight line towards the centre.

But now consider the case of an electric current flowing in a straight wire, and a magnetic pole placed in the neighbourhood of the wire. It would seem that if there be any force exerted between the current and the pole it must be in the plane containing them, since there is no reason why it should be to one side of the plane rather than the other. But in this case the argument from symmetry fails. The force exerted on the pole is at right angles to this plane, the pole tending to go round the wire one way, and not the other way, and this asymmetry pervades the whole science of electrodynamics.

This is perhaps one of the first and most striking instances of asymmetry noticed by the student of science; but as one continues to examine natural phenomena, one finds a lack of symmetry almost at every step. The chemist and physiologist find it every day in their study of the chemistry of vital products.

The element of most fundamental necessity for plant and animal life is carbon—the molecules of the various extremely complex substances known to physiological chemists are mainly built up upon frameworks of carbon atoms. Now it is well known that when the four valencies of a carbon atom, by which it is linked to the rest of the molecule of which it forms part, are satisfied by four different radicles, there is a possibility of two distinct conformations related to one another as an object and its mirror image. It is in many cases possible to detect these differences by the effects of the compounds in rotating the plane of polarized light.

Now, when compounds capable of existing in two enantiomorphous forms are synthesized from compounds not capable of asymmetry, there is no reason why one should be formed rather than the other, and so one would expect them to be formed in equal quantities. And up to the present (except for one or two unconfirmed statements to the contrary) this has always been found to be the case in the laboratory.

In the case of products formed in the various vital processes, this symmetry is, however, not observed. When a substance capable of existing in two optically antimeric forms is produced in a living organism, it is exceptional to find that the two are produced in equal quantities; and there would thus appear to be a fundamental asymmetry underlying vital chemical processes. Thus the sugars found in plants and animals are almost without exception optically active. And when an organism is capable of acting chemically upon such a substance, or the substance has a physiological effect upon the organism, then it is usual to find different effects with the two varieties of the substance.

For instance, of the tartaric acids, the dextro variety is destroyed in the animal body to a greater extent than the lævo form; and similar phenomena are exhibited by various other substances. The paralysing action of dextro-rotatory cocaine is stronger and more rapid than that of lævo-rotatory cocaine. Both varieties of nicotine are strong poisons, but the toxic effect of the lævo form is twice as great as that of the dextro form, and their physiological actions are different. Atropine and hyoscyamine have for some time been known, and their physiological properties made use of; and now it is known that atropine is an inactive mixture of two optical antimers of which hyoscyamine is one.

There is something asymmetrical even in our sense of taste; dextro-rotatory asparagin has a sweet taste, while the lævo form is tasteless. It is also stated, in a few cases, that the odours of optical isomerides are different, either in kind or degree.

Even the lowliest organisms, such as bacteria, which are of the utmost importance to the daily life of the higher organisms, have a very marked selective action in cases of stereo-chemical asymmetry. Yeast, for instance, is capable of causing the fermentation of dextro-glucose (ordinary grape sugar), but will not touch the lævo form. Again, *penicillium glaucum*, when grown in a solution containing dextro and lævo-rotatory lactic acids, destroys only the latter, leaving the former.

It is true that substances have been prepared in the laboratory in an optically active form; but the various methods used for their preparation involve the use of substances already optically active, so that all chemically asymmetric substances owe their origin either directly or indirectly to life in some form. Moreover, in the laboratory, at best a mixture of the two forms is obtained, containing one in excess; and in order to separate one of them in the pure state a lengthy process of fractional crystallization has to be resorted to.

In plants, however, we commonly find optically active substances in a pure state, the plant being apparently able to effect directly an asymmetric synthesis without, so far as we can see, any process of fractionation at all.

It is obvious that many cases of chemical asymmetry in physiological actions are closely related together. The same organisms which affect dextro-rotatory glucose also affect lævo-rotatory fructose. These are not two separate phenomena, but are due to the close similarity in structure between the two sugars, the same enzyme decomposing them both; just as (to use a simile proposed by Emil Fischer) the same key may open two locks of a similar, but not identical, structure.

It is probable that other physiological actions which do not show any obvious relations with each other may be in some way correlated together, in a manner that we could only understand if we had before us a complete history of the physiological evolution of the organisms in which they occur. Naturalists are familiar with cases of correlation between biological peculiarities in plants and animals, though the connection is not always known. For instance, white cats with blue eyes are almost always blind. In a certain species of *Brassica*, small roots and numerous seeds are found to be associated together.

And so it may be just possible to conceive that all cases of chemical asymmetry in physiological action may be traceable back to a few cases of asymmetry in the very lowly organisms with which life made its first appearance on the earth. Once the asymmetry has started, one may well suppose that evolution would continue on asymmetric lines.

The fact that a very small degree of asymmetry in the first stages of a process may, so to speak, turn the scale and upset the symmetry of the whole process is very well illustrated in geology. An ideal watershed is produced. This is perfectly symmetrical. Two parallel rows of springs arise on either side of the ridge and equidistant from it. Streams run down the slopes at right angles to the watershed, and by erosion give rise to logarithmic curves on either side of the ridge. As the springs cut back the watershed is no longer a straight line, but a

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perfectly symmetrical zigzag. And so on. This is the history of the ideal watershed. It is illustrated in any elementary book on physical geology. But actually no such thing occurs. A small pebble, perhaps displaced by a gust of wind, or by some passing animal, obstructs the first beginnings of one of these streams and diverts it from its straight course. It finds a path of least resistance that is not quite symmetrical. It runs into one of its neighbouring streams, and the erosion continues in an irregular manner. Thus the whole symmetry of the process by which continents are formed is upset.

If we consider the earth quite apart from any life upon it, it is plain that there is one very important property of the earth itself which is asymmetric, namely, its rotation; and it seems, therefore, most hopeful to look for the reason why organic evolution has taken place along asymmetric lines in this rotation, or in some phenomenon depending upon it.

Such a phenomenon is found in the circular polarization of light. The physical explanation of this phenomenon need not concern us here; it is sufficient that there is *something* not symmetrical about light that has been reflected from the surface of the sea. It has been suggested* that this may have some effect upon the first stages in the building up of chemical compounds in physiological processes.

An objection to this theory is that although the light at any particular spot on the earth has this asymmetric property, the effects are in the opposite directions in the two hemispheres. Hence, it is argued, we ought to expect all the asymmetric phenomena of life in one hemisphere to be counterbalanced by the opposite kinds of asymmetry in the other hemisphere. This, however, is not found to be the case. Plants or animals which produce an optically active substance produce the same variety of it all the world over; and, so it is stated, circularly polarized light cannot be the sought-for cause.

There seems, however, to be an argument against this objection. If, as was suggested above, the various manifestations of asymmetry are all traceable back to a few original cases, then the problem is merely the origin of these first cases, which must have been in one hemisphere or the other.

Another theory might be proposed to account for the first origin of asymmetry in carbon atoms. Namely, that instead of its being due to a slowly acting process such as that just considered, it may have been due to a very violent and sudden cause of an asymmetric nature, such as some violent electrical disturbance. This may well be imagined to have a very disturbing effect upon chemical molecules; and since the electrical discharge is asymmetrical its effect may be supposed to be asymmetrical.

We may imagine a little group of atoms and molecules suddenly affected by some such electrical catastrophe, and recovering from the shock only to find that their original symmetry has been irrevocably ruined; and that if they are to be the origin of the development of life such development will have to be along asymmetric lines.

The following thermo-electrical phenomenon† shows that there is some relation between asymmetric electrical effects and asymmetry of chemical structure: If crystals of dextro- and lævo-rotatory tartaric acids be warmed and then allowed to cool, pyro-electricity is generated, on the right-hand side of the crystal in one antimer, and on the left-hand side in the case of the other.

So far, chemical asymmetry has been chiefly considered, but many cases in other branches of science are also familiar. The shapes of organisms are in many cases asymmetrical; for instance, convolute shells are, with very few exceptions, coiled in the direction of a right-handed corkscrew. Climbing plants show a similar asymmetry in their habits.

Possibly most of these cases of morphological asymmetry are ultimately due to something of a chemical nature in the cells from which the organisms develop, and so are merely part of the original problem.

All these speculations have only, so far, referred to the origin and development of asymmetry upon this planet. But even if we can trace every single instance to the earth's rotation, we are, Sisyphus-like, as far as ever from the completion of our task.

Why does the earth revolve one way about its axis and about the sun? It does so as part of the solar system, which has been revolving ever since its origin from a revolving nebulous mass. But why did that revolve one particular way? Regarding the whole stellar universe as one system, it may be that the asymmetries exhibited by all the various stars and planetary systems are mutually compensatory; and so the universe as a whole may be symmetrical.

At this point it would appear that scientific speculation will not take us any further, and that from the scientific point of view the question must be left Not Proven.

But for those interested in metaphysical speculation about Time and Space, Ultimate Reality, and the like, there is much food for thought. In a lecture* delivered at the Royal Institution in February, 1870, Professor W. K. Clifford brought forward the suggestion, supported by arguments, mainly mathematical, that time is not continuous. In a cinematographic representation of moving objects, the appearance of motion is produced by a discontinuous succession of pictures representing the objects in relative positions, each slightly different from the last. The hypothesis formulated by Professor Clifford is that there is no such thing as true motion in the universe, but that the very existence of the universe itself is discontinuous, every successive appearance of it showing slightly different relative positions of its parts.

Probably one could most easily imagine the state of affairs proposed, by considering our three-dimensional universe as existing in relation with a universe of more than three dimensions; and supposing that the phenomena of our universe consist of projections into three dimensional space of phenomena that are part of a system of more than three dimensions. To complete our figure we should have to imagine that this projection is discontinuous.

Now consider a simple case of asymmetry in two dimensions such as a scalene triangle. Two scalene triangles could exist in a plane having their sides and angles equal "each to each," but the two triangles could be mirror images of one another, and so not be superposable. By no amount of shifting in the plane could one be made superposable on the other. But if we allow motion in three dimensions then either triangle may be converted into its mirror image by turning it over, about one of its sides, and replacing it in the plane. In the same way, if we bring in the consideration of four-dimensional space in reference to three-dimensional asymmetry, we find it would be possible, in imagination, for, say, a left-handed glove to be converted into a right-handed one; or for the molecules of an optically active chemical substance to be converted into those of its optical antimer.

* Byk. *Zeit. Physikal. Chem.* 49, 641 (1904). *Ber. der Deutsch. Chem. Ges.*, 37, 4696 (1904).

† A. W. Stewart: "Stereochemistry," p. 49.

* "On Theories of the Physical Forces." Lectures and Essays by W. K. Clifford; edited by Leslie Stephen and Frederick Pollock, 1879, p. 109.

Now if it be possible to suppose such relationships between our three-dimensional universe and four-dimensional space (always remembering that the relationship is not suggested as a fact, but only as a figure for imagining the state of affairs suggested by Professor Clifford), then there seems to be no reason for supposing that each time the projection into three-dimensional space takes place it should occur the same way; and so all the asymmetric phenomena of one instant may be reversed the next. If this were so, then the phenomena would not be really asymmetric in themselves, only appearing so at any particular instant in three-dimensional space, and to minds like ours that can only grasp things in three dimensions; in the same way that the scalene triangle is asymmetrical when it is confined to a plane of two dimensions, its symmetry only appearing when it is regarded from the point of view of three-dimensional space.

Of course, if such a perpetual reversal of the whole universe were constantly going on, we should be none the wiser, since our way of thinking about things would change as often as the things themselves. *Tempora mutantur, et nos mutamur in illis.*

Solar Disturbances During March, 1909.

THERE has been a marked preponderance of activity in the southern hemisphere during March, though great disturbances have occurred on both sides of the equator. At noon on March 1 the longitude of the central meridian was 152° 43′.

Nos. 21, 22, 23, 24, and 25 of the February list remained on the disc during the early days of March, and so appear upon the present chart.

No. 26.—A pair of pores 34,000 miles apart on the morning of 5th, but in early afternoon there were eleven, not, however, seen again.

No. 26*a*.—A solitary pore visible 12th-13th.

No. 27.—A spot having a diameter of 14,000 miles on 13th, when it was attended by four or five smaller spotlets, the group being 37,000 miles across. A two-umbræ spot on 16th, reduced to a faculæ surrounded pore on 19th. Seen 8th-19th.

No. 27*a*.—A group of pores forming an imperfect ellipse 15th-16th; a line 30,000 miles long on 17th; but only a pore when last seen on 19th.

No. 28.—A fine group, its leader being 22,000 miles in greatest length, the bright bridges on 21st being particularly interesting. At its maximum on 25th the length of the outbreak was 119,000 miles. Some very narrow brilliant bridges crossed the penumbra of the large spot on 27th. 19th-29th.

No. 28*a*.—A spot 12,000 miles in diameter usually seen with two umbræ, and alone. On 21st, however, there was a pore east, and on 29th three between west and south-east. 19th-31st.

No. 29.—A pore only visible 15th.

No. 30.—A group of small pores covering the same area as No. 21 The greatest length, 23rd to 25th, was 78,000 miles, but by 27th only gray pores were visible. 19th-27th.

No. 30*a*.—First seen 20th; on 21st a group of five or six large pores; 23rd two small spots with a following of pores. Subject to constant change, its greatest length being 119,000 miles, and the greatest diameter of its spots being 17,000 miles. 20th-29th.

No. 31.—First developed 22nd; on 23rd three pores; by 25th a larger spot with pores around, whilst eastward a group of pores 31*b* had opened, and a very black spotlet 31*a* had broken through a little north, this last not being seen again. The diameter of 31 reached 8000 miles, but the whole outbreak was constantly changing form, the greatest length being 82,000 miles, and the greatest diameter of any member 19,000 miles, covering the same district as No. 22. Last seen April 2.

No. 32.—A spotlet with a pore east on 23rd, the companion pore being westward on 25th and 27th, 27,000 miles distant. Only a pore visible when last seen on 29th.

No. 33.—A pair of pores 28,000 miles apart only seen on 29th. A minute pore showed for a while a few degrees south-east of the place on 31st.

No. 34.—A pair of spotlets only seen on 29th and 31st.

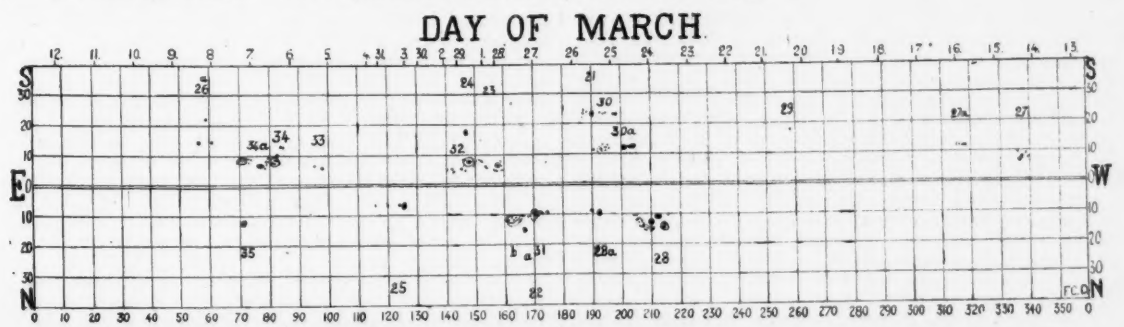
No. 34*a*.—On 29th another spotlet north-east was included in the same faculic disturbance with 34. Two days later this had increased to a group 85,500 miles long. The leader on April 1 being 13,000 miles in diameter showed a cyclonic whorl of penumbra westward. By next day it had enlarged to 22,000 × 17,000 miles in area, the group being 96,000 miles in length. The rear pores collapsed by 4th into a large penumbral spot some 30,000 miles in greatest diameter, which two days later had shrunk considerably. Last seen in a faculic area within limb on April 9.

No. 35.—A solitary spot 14,000 miles in diameter, very slowly diminishing, crossed the disc March 29 till April 9.

A "disturbance" shown on February chart, longitude 220°, north latitude 3°-12°, is really caused by a flaw on the block.

The chart is constructed from the combined observations of Messrs. J. McHarg, A. A. Buss, and F. C. Dennett.

Note: The photographs by Messrs. P. Fox and G. Abetti, reproduced upon p. 149, show the formation of groups in May, 1907, and September, 1908, those in the latter being Nos. 130, 132, and 133 on the chart in our November number.



NOTES.

ASTRONOMY.

By CHARLES P. BUTLER, A.R.C.Sc. (Lond.), F.R.P.S., F.R.A.S.

CONSTITUTION OF THE RING NEBULA IN LYRA.—Professor Max Wolf recently obtained most interesting photographs of the spectrum of the Ring Nebula in Lyra, Messier 57, using the Waltz reflector. A peculiar feature of these was that the carefully determined dimensions of the ring images in the different radiations corresponding to the nebular lines were found to vary. Commenting on this feature, Professor Brauner, of the Bohemian University, Prague, writes to *Nature* suggesting that it may indicate the rapid rotation of the ring matter, and the different diameters may correspond to the actual centrifugal separation of the component gases. He divides the radiations measured by Professor Wolf into four types, as follows:—

Size of Ring Image.	Element.	Density.
1 Smallest λ 469	unknown	?
2	hydrogen	2.016
3	helium	3.96
4 Largest λ 373	unknown	?

Quoting Bredig's observations that in a mixture of gases under centrifugal rotation, the relative concentration of the gas with the higher molecular weight increases with the velocity of rotation, and remembering that there is a vacant place in Mendeljeef's periodic law for an element of less density than hydrogen, it is suggested that one of the unknown gases mentioned above may correspond to this, and would have an atomic weight of about 0.4. It is to be hoped that chemical investigators will endeavour to trace any evidence for the existence of an element of these properties.

SOLAR PHYSICS OBSERVATORY, KODAIKANAL, INDIA—REPORT FOR 1908.—In his report for the year 1908, the Director records a very successful year's work, the general weather conditions for the year having been very favourable. *Photographs of the sun*, with the Dallmeyer photoheliograph, giving about an 8-inch image, were obtained on 338 days; several of these were sent to Greenwich to fill gaps so as to complete the record for the year. Double exposures are taken twice a month for determining the error of orientation of the pictures. A number of large scale photographs of individual spots have been taken with the 20-ft. and 40-ft. lenses. The mean latitude of spots varied somewhat irregularly from month to month, but was less for 1908 than for 1907, being about 9°.9 in the northern hemisphere, and 10°.7 in the southern. *Photographs of sun-spot spectra* were obtained in the regions C-D and G-K, showing many new interesting features. General spectroscopic investigations were carried out, dealing with rotation velocities of the higher gases of the chromosphere, and of the quiet prominences at a great height above the sun's limb; the relative shifts of certain lines in spot and limb spectra; general shift towards the red of Halm's lines at the limb; differences in relative intensities of lines in spectra of sun's limb and centre, and relation of limb to spot spectra. *Prominences* were recorded visually on 310 days, and the record was compared with the photographic pictures made with the spectroheliograph. In cases of eruptive prominences being detected their spectra were examined in detail. The number of prominences recorded shows that the year was one of great activity. A notable feature was the activity displayed at the southern polar region. In the northern hemisphere two zones were indicated in latitudes 10°-15°, and 30°-35°, while south of the equator the active zone was from 15°-20°, with a secondary maximum near 45°-55°. Metallic prominences were far more numerous in the southern hemisphere, and extended over a greater range of latitude. *Spectroheliograms* of the flocculi on the disc (in K2 light) were obtained on 337 days, and of the prominences round the limb on 300 days. Observations of *solar radiation* with an Angstrom Pyrheliometer were begun in February, 1908, and were made on all suitable days. These are usually numerous during the first four months of the year, but rare during the rest of the year.

SEARCH FOR PLANET BEYOND NEPTUNE.—The complete investigation of Professor W. H. Pickering has now been published, dealing with the evidence from which he concluded that there is in existence a planet farther from the sun than Neptune. The main point of the investigation is that by employing graphical analysis, he has avoided many of the very laborious computations which had to be undertaken for determining planetary orbits from perturbations. He illustrates the value of the method by determining the position of Neptune from the perturbations of Uranus, and shows that the result is sufficiently accurate to have given the place of Neptune as it was discovered. Then the method is applied for the supposed new planet, by analysing the observed perturbations of Neptune, and the complete predicted elements are given. Reference is also made to other predicted places from cometary observations, etc.

ELEMENTS OF SUPPOSED ULTRA-NEPTUNIAN PLANET.

Epoch	1900 0	Angular diameter if of same mass as Neptune	0".8
Longitude	105°.8	Magnitude if same albedo as Neptune	11.5
Mean distance	51.9	Magnitude if same albedo as Mars	13.4
Period	373.5	R.A. in 1909.0	$7^h\,47^m$
Mean annual motion ..	0°.964	Decl.	+21°
Mass in terms of sun ..	$\frac{1}{19000}$		
Mass in terms of earth ..	2.0		

BOTANY.

By G. MASSEE.

BOTANISING IN ICELAND AND SPITZBERGEN.—Iceland and Spitzbergen are usually associated in the mind with snow-clad mountains, glaciers, and intense cold, but the description of these countries given by Julia T. Emerson, in *Torreya*, during the month of July, indicates that a botanist would be likely to come across ample material for study. In Iceland the first town visited was Reykjavik, and amongst cultivated plants observed were mountan ash and sycamore, both dwarfed to five or six feet in height, *Ribes alpina*, *Lonicera*, in bloom, rhubarb, potatoes, poppies and young cabbages, *Caragana sibirica*, tulips, phlox, forget-me-not, *Sorbus*, and a bunch of *Coprinus* on a lawn. A few miles inland, near the hot springs, cotton grass was common in damp localities, in addition to small flowering plants, such as the following:—*Statice maritima*, *Silene maritima* and *S. acaulis*, *Polygonum viviparum*, *Alchemilla alpina*, *Galium verum*, and *Todfieldia palustris*. In the vicinity of Akreyri, the second largest town in Iceland, *Dryas octopetala* was common, *Parnassia palustris*, *Viola tricolor* made bright patches of colour; *Pinguicula vulgaris* was growing in cracks of the damp rocks, yarrow, dandelion, and sorrel were also present, in addition to several species of mosses.

Advent Bay was the place chosen for investigating Spitzbergen. Here the valleys are filled with great glaciers, whose ends break off into the waters of the Bay, which is also said to be the terminus of the Gulf Stream. A plateau of great extent, about six feet above the level of the shingle beach, proved to be a natural garden with many dainty little flowers about six inches high. Here were the Iceland poppy (*Papaver radicatum*), *Saxifraga oppositifolia*, pink and white and delicately fragrant, *Pedicularis lanata*, *Potentilla emarginata*, and *pulchella*. *Cassiope tetragona* made quite a turf where melting snow was near it, and was

accompanied by the tiny willow, *Salix retusa*. Mosses were also fairly abundant.

The North Cape of Norway was next visited, and it seemed like being in the tropics to see such a luxuriant growth of grass, buttercups, geraniums, sweet yellow violets, pink campion, saxifrages, etc. At midnight, when the sun was just at its lowest point, good photographs were taken. In the Lyngenfiord, still well to the north of the Arctic Circle, white birches and many kinds of flowers were seen. Finally, at Digermulen, on the Lofoten Islands, white heather, violets, *Cornus succica*, *Lotus corniculatus*, *Trientalis europæa*, *Vaccinium vitis idæa*, *Andromeda polifolia*, dwarf willows and birch, also many mosses and ferns were noted during the ascent of a mountain about 1,100 feet high.

THE DEATH CAMAS.—According to A. A. Heller in *Muhlenbergia*, "death camas" is a local term applied to several allied plants belonging to the Liliaceæ, possessing poisonous properties, but more especially to the "wild onion," *Toxicocordion paniculatum*, Rydb., a stout plant with a branched inflorescence and small creamy-white flowers. The plant is deep rooted, with a bulb six inches or more below the surface of the ground; its leaves appear early, and in May a single flower stalk shoots up. It grows on hills up to an altitude of 1,500 m., ranging from Montana and Washington to New Mexico and California. Many persons have suffered owing to having mistaken the plant for onions. The various allied species are responsible for the death of large numbers of grazing animals, some species being probably more deadly in their effects than others.

Convallamarin is the poisonous substance present, more especially in the root, and this substance, according to the American Dispensatory, is very deadly, causing death in a few minutes after the introduction of the poison.

GUMMOSIS.—Gummosis is the term used to express the formation of masses of gum on the trunk and branches of many different kinds of trees. The cause of gumming has been attributed to different species of fungi, and to defects in culture respectively. Dr. R. Greig Smith gives an account in *Proc. Linn. Soc. N. S. Wales* of his researches bearing on this subject, and shows that gumming in acacias is due to the presence of a bacterium; and furthermore, when a peach tree was infected with the bacteria gumming followed, whereas control trees remained free from gumming.

Up to the present it has been generally assumed that gum resulted from the decomposition of cellulose. This assumption, however, proves to be incorrect; gum acacia is not formed from cellulose, but in the host-plant it is formed from the wandering sugars, levulose and maltose. It has been stated that the application of common salt (sodium chloride) checks gumming. Dr. Smith's experiments, however, do not support this view, and he considers that manuring with saline matter does not promise to be a remedy for the prevention of gum-flux in fruit trees. The quantity of sodium chloride which would affect the bacterium would also injure the tree. Possibly something might be gained by the use of small quantities of potassium nitrate, which would act as a plant stimulant and as a bacterium depressant. The formation of gum is favoured by a cold season, or by the tree growing in a cold, damp situation. The healthiness of the tree is of primary importance, and good drainage is essential.

CHEMISTRY.

By C. AINSWORTH MITCHELL, B.A. (Oxon.), F.I.C.

THE ROSE OIL INDUSTRY.—The bulk of the "otto" of roses of commerce is derived from Bulgaria and Roumania, "the rose garden of the world," where the soil and climate are particularly suited for the cultivation of the varieties of rose that yield the best oil. A certain quantity of fine oil is obtained from the South of France and Algiers, while roses are also cultivated for distillation in Germany, though the product is less valued than the Balkan oil. The method of preparation used in Bulgaria is very primitive, the leaves being distilled with water in stills of the simplest construction. In order to obtain the best results it is essential that the leaves should be gathered before they have been heated by the sun's rays, and the work is, therefore, discontinued soon after sunrise. The distillation takes place as soon as possible after the leaves have been picked, and in many cases neglect of this precaution results in the production of an inferior oil. According to a recent communication by Herr Marpmann to the *Zeitschrift für Riechstoffe*, the stills in Bulgaria during the last season were quite unable to cope with the supplies of roses brought in, and large quantities of leaves were, consequently, spoiled. He suggests that whenever there is unavoidable delay in distillation the leaves should be mixed with a large proportion of salt and tightly packed in barrels. The methods of extraction might also be considerably improved, *e.g.*, by the use of a liquid paraffin hydrocarbon in the separation of the oil. Under the present conditions of distillation in Bulgaria the yield of oil from the leaves of *Rosa damascena* is about 0.1 per cent., but the yield largely depends upon the kind of season, less being obtained in a dry than in a wet summer. Adulteration of rose oil is widespread, and, owing to the high price of the genuine product, is very profitable. The chief substance used for the adulteration is geranium oil, which is usually added to the final distillate, although, with the object of obtaining better admixture, the rose leaves are sometimes sprayed with it before being placed in the still. The addition is often extremely difficult, if not impossible, to detect. The melting point, specific gravity, and optical rotation are regarded as valuable criteria of the purity of rose oil, but it is quite possible to prepare mixtures of rose and geranium oils which will give figures for these constants falling within the limits recorded for genuine rose oils. In such cases the expert judgment of an oil by its odour is often of greater value than the results of physical or chemical tests.

UTILISATION OF LOCUST BEANS.—The separated cotyledons of the seeds of the locust bean are used as the source of the gum-like mass known as "gum-tragasol." They are disintegrated by treatment with water and steam under pressure, and the resulting viscous mass expressed in silk bags in a press, preserved by the addition of an antiseptic agent, and allowed to solidify. As thus obtained gum-tragasol readily absorbs moisture, but is only sparingly soluble in water. A dry sample recently analysed by Messrs. Lamb and Farrell contained 43.51 per cent. of carbon, 6.23 per cent. of hydrogen, 48.38 per cent. of oxygen, 0.39 per cent. of nitrogen, and 1.49 per cent. of mineral matter. When made into an emulsion with water it is used for sizing table linen and for dressing leathers. When a strong solution, or, rather, emulsion, is allowed to set it yields a very strong and plastic film. Its usefulness for many practical applications is increased by the fact that it can be mixed with starch, paste and with fats, with both of which it probably forms a sort of combination. On the other hand, it costs more than starch and the mucilages used in leather dressing, although, according to Messrs. Lamb and Farrell, it gives better results. In particular it increases the resistance of the dyestuffs in dyed leather to the mechanical action of rubbing.

THE PROPORTION OF PHOSPHORUS AND IRON IN VEGETABLES.—A series of analyses giving the proportion of phosphorus and iron in various vegetables and fruits has been published by Herr Haensel, and shows many points of interest. The amount of phosphorus expressed in terms of phosphoric acid fluctuates widely, as is shown by the following typical results:—Lettuce, 0.127; winter cabbage, 0.204; spinach, 0.135; celery (head), 0.223; (leaves), 0.172; radish, 0.106; tomato, 0.057; potato, 0.162; mushroom, 0.143; apples, 0.018; and bananas, 0.03 per cent. The low proportion of phosphorus in the banana is somewhat surprising.

The amounts of iron expressed in terms of ferric oxide, ranged from 0.0003 per cent. in bananas and 0.0007 per cent. in apples to 0.055 per cent. in lettuce and 0.056 per cent. in winter cabbage, which is thus seen to be among the richest both in phosphorus and iron. Potatoes were rich in phosphorus, but poor in iron (0.001 per cent.), while mush-

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rooms contained but little of either element. Beetroots, radishes, and tomatoes obviously owe little of their colour to iron, since they contained no more than 0.008, 0.004, and 0.0006 per cent. respectively. In red cabbage, again, the proportion of iron (0.002 per cent.) was lower than that present in white cabbage (0.003 per cent.).

Estimations were also made of the quantities of water in the various vegetables. They ranged from 78.3 per cent. in potatoes to 92 per cent. in lettuce, and 93.1 per cent. in tomatoes. In most cases the proportion was about 84 to 86 per cent.

GEOLOGY.

By EDWARD A. MARTIN, F.G.S.

THE MAMMOTH AT SELSEY.—The discovery of a small mammoth on the shore at Selsey Bill, Sussex, is interesting. The greater portion of the skeleton has been obtained, and it was found imbedded in the clay beneath the raised beach at this spot. Stormy weather appears to have laid it bare, owing to the removal of the shingle which had hitherto covered it. Many more fragmentary remains of the *Elephas primigenius* have been found from time to time on our southern coasts, and no doubt the animal was to be found in fair numbers in the times represented by the Pleistocene deposits of Sussex. It will be remembered that the Coombe rock resting on the raised beach of the Brighton cliffs was called by Mantell the Elephant Bed, in consequence of similar remains having been found therein, whilst the Coombe rock at Freshwater gap at one time yielded parts of this ancient elephant.

THE COON BUTTE METEORITE.—From the Report of the Smithsonian Institution for the year ending June 30, 1908, we glean some interesting particulars of the so-called crater at Coon Butte, Arizona. We have on a previous occasion referred to the probability of its having been formed by the impact of an enormous mass of meteoric material with the earth, and the suggestion has been made, with some reason, that some of the lunar features have been formed in a similar manner. This is, however, an astronomical matter. Dr. G. P. Merrill has arrived at the conclusion that this crater could not have been formed by volcanic action. It appears to be about three-quarters of a mile in diameter and about five hundred feet in depth in sedimentary rocks. These have been shattered as by some powerful exterior agency, and there is little doubt as to the origin of the crater. Specimens of Arizona meteorites are known all over the world, and most of them may reasonably be held to be exploded fragments cast off by the main mass in its transit to the earth. In order to account for the absence of a meteorite sufficient to have caused the crater, it is shown that this may have been dissipated by the heat generated on its impact with the earth. Numerous borings were made into the rocks in order to set the matter at rest, one of them reaching to a depth of 842 feet.

THE WASTE OF NATURAL ENERGY.—Sir William Ramsay's speech before the annual meeting of the British Science Guild contains an allusion to the waste of energy which is going on in our country, in the consumption of coal, which may well make the average man pause and think. *Nature* has recently printed some extracts therefrom, and we are indebted thereto for the summary. "The life of a nation," said Sir William, "depends not only upon the fitness of the people, but upon the amount of natural energy which is available to be used for driving power. We know pretty well from the results of the Royal Commission that our coal mines will not last for an indefinite time. Some say three hundred, others eight hundred, years. Let us put it at five hundred. It is only right and natural that we ought to have some consideration for persons living three or five hundred years hence. We ought in the present day to have consideration for the generations who will succeed us, and who will either profit by our foresight or regret our stupidity. Now, in this country our water-power is quite insignificant, and, indeed, if it were much larger than it is there is not much to be made of it. It has been calculated that the total water-power of Europe, excluding, perhaps, some few rivers in northern Russia, is equal to 2,000,000 horse-power. Why, we use 100,000,000 horse-power in England, so that even if we possessed the whole water-power of Europe we should hardly be supplying one-fiftieth of what we use from coal. I know there is a popular superstition that in view of the extraordinary inventions which we are witnessing in these days—long-distance telegraphy and so on—something will be discovered in the future which will replace our present source of energy. One cannot say with absolute certainty that that will not happen, but I think any scientific man will say it is in the highest degree improbable. And what else have we to come and go upon? You may say that we might have an apparatus to utilise the tides; but the first storm knocks to bits any apparatus. Or solar heat? Again the first storm plays havoc with any machinery—and that of the costliest. One possibility is to dig a big hole deep enough into the earth and hope to get boiling water. Without that possibility, there is no other source of energy. Now this points to the economisation of coal. It points to legislation in other directions. Are we going to limit the use of steam engines? Gas engines give us about three times the power for the same consumption of fuel. Are we going to pay attention to the afforestation of the country, so that when coal is done we shall still have wood? Are we going to stop the enormous loss of nitrogen, which is so serious, that it will be impossible after fifty years to get the necessary amount for the growth of our plants? Are we going to utilise our sewage? All these are questions of first importance, and I think the Guild should appoint a committee to see how we can save the waste that is going on, and so give our country a chance of longer life. It would be horrible to look forward to London becoming a fishing village of five to ten thousand people, built on the top of some magnificent ruins and supported by scanty agriculture. But it is only what we should have to look forward to unless something is done. Let us postpone that evil day as far as possible."

GLACIAL EROSION IN NORTH WALES.—An excursion around Snowdon in September, 1907, followed by a further visit in 1908, led Professor W. M. Davis to the conclusion that a large-featured, round-shouldered, full-bodied mountain of pre-Glacial time had been converted by erosion during the Glacial Period—and chiefly by glacial erosion—into the sharp-featured, hollow-chested, narrow-spurred mountain of to-day. The results of his observations were communicated in a recent paper to the Geological Society. The peculiar indifference of topographic form to the trend of formation-boundaries and the insequent stream-arrangement, are what might be expected as the result of prolonged erosion upon a mass of complicated and resistant structure. Referring to Ramsay's theory of a plain of marine denudation, Professor Davis is of opinion that the upland seems to deserve classification rather with peneplains; he suggests for it a Tertiary date, which would not be inconsistent with the erosion of open valleys in the uplifted peneplain after its elevation, and argues that Snowdon and its high neighbours had a relief of some 2,000 feet above the plain. As the result of a comparison with the non-glaciated regions of Devon, it is considered that the dissection of North Wales must have been somewhat less developed in pre-Glacial times than in Devon to-day. On this assumption it is possible to make a tentative restoration of the pre-Glacial form of Snowdon: subdued mountains, with dome-like summits and rounded spurs, drained by prevailingly graded streams of accordant levels at their junctions. In fact, the characters were those of "moels" such as Moel Tryfaen, or like the well-worn Appalachian Mountains of North Carolina, or the Cévennes. The chief abnormal features of Snowdon are the following:—Alongside the graded summit and slopes of a "moel" stand the head-cliffs of a rock-walled cwm, in the floor of which talus is now accumulating. The cwm-floors are generally stepped, sometimes more than once, and the streams cascade down into the valleys. The cross-profile of the valleys is often a fine

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catenary curve, down the sides of which streams fall from hanging valleys. The slope of the main valleys occasionally decreases even to the point of reversal, as where lakes occur; and in the immediate neighbourhood of smoothly-graded, waste-covered slopes, knobby or craggy ledges and bars of rock often appear. After pointing out that such features are generally associated with glaciation, Professor Davis proceeded to discuss two out of four possible hypotheses put forward: "that glaciers are essentially protective agencies," or that they "are active destructive agencies." The consequences deduced from the hypotheses are confronted with the actual facts, and it is found that these, and especially those relating to rock-steps, cannot be explained on the protection-theory, while the theory of a destructive agency seems to explain most of the facts.

METEOROLOGY.

By WILLIAM MARRIOTT, F.R.Met.Soc.

REMARKABLE SUNSHINE AND DRYNESS.—The weather during the week preceding Easter Monday was of a very remarkable character. The sky was almost cloudless, and there was continuous sunshine by day and clear sky by night. Over the kingdom generally (according to the "Weekly Weather Report") the week was among the brightest ever recorded, the percentage of the possible duration of sunshine ranging from 89 in England E., 87 in England S.E., 82 in the English Channel, and above 70 in the other English districts to 51 and 48 respectively in Scotland W. and N.

The air was very dry, especially on Good Friday, April 9. The mean relative humidity at the Royal Observatory, Greenwich, on that day was as low as 40 per cent. This low value has only been once surpassed, viz., on December 20, 1855, when the mean for the day was 34 per cent.

MIRAGE AT GRIMSBY.—An account has been given in the *Times* of a wonderfully vivid mirage which was witnessed from Grimsby on April 8. The Humber is six miles wide there, and beyond is three miles of land. This appeared to be lifted high into the air and reversed, the trees inland having the appearance of growing upside down. The Spurn Lighthouse, reversed, was seen four miles from its position, and below the reflection of the land was the North Sea on which were large steamers with masts and funnels downwards, passing to and fro. The spectacle was unprecedentedly clear. It is ascribed to the dry easterly wind which was prevailing at the time.

PERCOLATION AND EVAPORATION AT CROYDON.—At the meeting of the Royal Meteorological Society, on April 21, Mr. Baldwin Latham gave the results of the observations on percolation, evaporation, and condensation which he has carried on at Croydon during the last 30 years. Two percolation gauges were used, both of which were exactly a superficial yard in area, and contained a cubic yard of natural soil, one of chalk and the other of gravel. The average annual amount of percolation through the chalk gauge was 10.84 ins., and through the gravel gauge 10.34 ins. The average yearly rainfall was 25.46 ins. It appears that the rate of percolation is governed by the rate of rainfall, for when once the gauges have become sensitive by being thoroughly wetted, the rate at which rain percolates depends entirely on the quantity of rain immediately falling.

The evaporator used for determining the evaporation was a floating copper vessel 1 foot in diameter, supported by a lifebuoy ring connected by four arms with the evaporating vessel, the whole being floated in a tank 4 ft. diameter containing about 3 ft. depth of water. The average annual amount of evaporation by this gauge was 18.14 ins., and the average amount of condensation was .36 in.

DAMAGE BY LIGHTNING.—Mr. Alfred Hands has been engaged for some time in compiling a chart of England and Wales showing the places where damage by lightning has occurred, and also the nature of the objects struck. In a recently published little book, entitled "Lightning and the Churches," he states that during the period from 1897 to the commencement of 1908 there were 7,793 instances of damage, which were distributed as follows:—

211 cathedrals, churches, and chapels.
3,190 other buildings of various kinds.
226 ricks and stacks.
1,251 trees.
194 persons killed.
1,016 persons injured.
1,307 cases in which animals were killed.
398 objects not covered by the foregoing classes.

As regards the animals killed, it is pointed out that the cases vary from single ones to as many as 40 in a flock, and by one stroke of lightning, and that the total number killed during this period would probably amount to 5,000 or more.

ESSAY PRIZE IN METEOROLOGY.—The Council of the Scottish Meteorological Society offer a prize of £20 for the best essay on a meteorological subject. As an indication of the kind of essay which the Council are prepared to consider, the following subject may be mentioned:—"A discussion of the extent to which the heat set free when water vapour is converted into the liquid state influences the temperature of the atmosphere, with special reference to the climatology of different parts of Scotland." The Council, however, wish it to be clearly understood that an essay on any other subject will be equally eligible.

The competition is open to regular matriculated students of the four Scottish Universities, including University College, Dundee, who have attended classes of Mathematics and Natural Philosophy, or to graduates of the Scottish Universities who on January 1, 1910, shall be of not more than five years' standing.

The essays must be sent in not later than March 31, 1910. Further particulars may be obtained from the Secretary of the Scottish Meteorological Society, 122, George Street, Edinburgh.

ORNITHOLOGY.

By W. P. PYCRAFT, F.L.S., F.Z.S., M.B.O.U., &c.

THE MIGRATION OF GROUSE.—Hitherto, of our native game-birds, only the quail has been regarded as a migrant, though the red-legged partridge shows occasional migratory tendencies. But Mr. H. B. Macpherson, in the *Field* (April 24), shows that Grouse must now be regarded as partial migrants, though their movements are restricted in area. Briefly, it would seem, under stress of weather caused by heavy snow-fall, Grouse migrate from the high to the low lands, being driven thereto by the lack of food. In the spring the return journey is made, and it would seem that when this takes place the immigrants are accompanied by the more vigorous of the lowland-bred birds, thus depleting moors previously well stocked. This state of things is similarly traceable to lack of food, for with the increased numbers thrown upon the lowland moors during the winter months the food supply becomes exhausted, while the higher regions now afford abundant provender.

Mr. Macpherson's observations, of which we can give but the barest outline, are the more interesting because they stand in such striking contrast to the account of the behaviour of Grouse during heavy snow given by another and no less keen student of birds—Mr. Abel Chapman. In his "Bird Life of the Border," this author tells us that when the snow lies thick the Grouse drive deep tunnels beneath its surface, "a perfect net-work of burrows—most nearly resembling a rabbit-warren." Here, like their cousins, the willow-grouse, Mr. Chapman assures us they find both food and shelter till the snow melts again.

There are some who assure us that we have little or nothing new to learn about our native birds, but these two very different accounts of the habits of the same species do not support this contention.

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ALPINE SWIFT IN PEMBROKESHIRE.—Mr. C. J. Carr, in *British Birds* (April), records the fact that an Alpine Swift was shot on the estate of Colonel Mirehouse, on the east side of Angle-Bay, Pembrokeshire, on November 20. It was apparently one of a pair which had haunted the locality for some time previously.

WHITE-TAILED EAGLE IN ESSEX.—In *British Birds* for April Mr. Christopher J. H. Inver records the fact that a White-Tailed Eagle was seen by him soaring over the park at Weald Hall, Brentwood, on February 6.

THE ARRIVAL OF SUMMER MIGRANTS.—The following interesting list of arrivals has appeared in the *Field*:—

Wheatear	near Cardigan ...	Mar.	21
	Seaton, Devon ...	,,	22
	Kensington Gdns., Ldn.	,,	22
	Windermere ...	,,	31
Willow Wren ...	Exebridge, Devon	,,	30
Chiff-chaff	Cuckfield ...	,,	29
	Horsham	,,	29
	Exebridge ...	,,	29
Swallow	Exebridge ...	,,	30
House Martin ...	Tempsford, Bedford	Apr.	4
	Yarmouth (I.W.) ...	,,	6
Sand Martin ...	Seaton, Devon ...	Mar.	30
Swift	Exebridge, Devon	Apl.	20
Wryneck	Aldington, Kent ...	,,	31
Stone Curlew ...	Warminster, Wilts	,,	29
Whitethroat	Roxton, Bedfordshire	Apl.	4
Ring Ousel	Llandilo, S. Wales	,,	5
Wood Wren	Otterbourne, Hants.	,,	11
Redstart	Aldingham, Suffolk	,,	8
Tree-Pipit	Hitchin	,,	10
Cuckoo	Weybridge ...	,,	10
Nightingale	Hitchin, Herts ...	,,	12
Black-Cap	Walsall	,,	19
	Hawkhurst, Kent...	,,	19
Lesser Whitethroat ...	Enfield	,,	14
Sedge Warbler ...	near Salisbury ...	,,	17
	Leiston, Suffolk ...	,,	21
Red-Backed Shrike ...	near Salisbury ...	,,	17
Yellow Wagtail ...	Aldeburgh ...	,,	16
Winchat	Walsall	,,	21
Common Sandpiper ...	Exebridge Devon...	,,	8
	Brecon	,,	15
	Harbottle, Northumberland	,,	16

PHYSICS.

By PROFESSOR A. W. PORTER, B.Sc.

ELECTRIFICATION PRODUCED BY FRICTION.—Experiments are described by Mr. Morris Owen, made with the view of extending our knowledge of the amount of electrification produced by friction. Little attention has been paid to this question since the time of Péclet (1834), who measured the amount produced by friction under various conditions as to the nature, pressure and velocity of the rubbing surfaces. Péclet concluded that insulated surfaces acquire, after a sufficient amount of friction, a constant surface density which is independent of the pressure applied during the friction. Mr. Owen has employed as materials, ebonite and slate (in which case the ebonite becomes negatively electrified), ebonite and copper (ebonite positive), glass and copper, glass and slate (the glass being positive in both cases).

The method employed was to take a heavy slate wheel as rubber; setting it in motion by a weight falling a given distance and bringing the second material up to it and letting them rub together under given pressure till the wheel is brought to rest. The work done is equal (neglecting friction at the axle) to the kinetic energy stored in the wheel by the falling weight.

The results show that with a sufficient amount of frictional work the charge produced reaches a constant maximum value; that this maximum is independent of the pressure applied during the rubbing, but that the maximum is reached with a smaller quantity of work the greater the pressure. Taking the case of ebonite and slate, for example: with a pressure of 2579.2 grams weight, the maximum was reached after about 40 million ergs, while with a pressure of 306.8 grams weight it requires about 200 million ergs. The pressure quoted is the total force between the surfaces. The maximum charge produced was about 2.57 electrostatic units. To complete the investigation the area of contact should be obtained so as to determine the data per unit area; but it was not possible to do this with accuracy, and it was not attempted to be done.

The author points out that after a rod had been recently rubbed several times the maximum was reached with less expenditure of work than required for a first rub. In no case, whether after recent rubs or not, did mere contact of wheel and specimen without rubbing produce even the slightest evidence of charge.—(*Philosophical Magazine*, April.)

CARBORUNDUM AS A RECTIFIER.—Professor G. W. Pierce has extended his researches on the property of carborundum in acting as an electric valve. When a piece of this substance is placed in a clamp between contact electrodes, the arrangement permits the passage of a greater current in one direction than in the other under the same applied voltage. Thus this device can be used as a rectifier for small alternating currents. With one specimen under an electromotive force of 30 volts, the current in one direction is 4,000 times as great as the current when the voltage is reversed. The maximum current is only small, viz., about 3 milliamperes in the case just cited, yet even so the device may have useful applications to cases in which small alternating currents are being tested; and it has the advantage that it is constructed entirely of solid parts.

If both surfaces of the carborundum are platinised so as to ensure complete contact with the electrodes the rectification, though not entirely eliminated, is rendered very imperfect. On the other hand, if one surface only is so treated the rectification becomes more perfect. The action apparently arises, judging from these results, at the surfaces of contact.

The effect is also obtained with other crystals such as anatase, brookite, and molybdenite. Nothing is said in the paper as to whether the effect depends upon the relation between the line joining the electrodes and the crystallographic directions. The experiments with molybdenite MoS_2 (which occurs in the form of tabular hexagonal prisms) were made with slabs cleaved parallel to the base of the prism.—(*Physical Review*, March, 1909.)

ZOOLOGY.

By R. LYDEKKER.

ARMOURED AFRICAN REPTILES.—I have been favoured by Dr. Broom, of the South African Museum, Cape Town, with a note concerning the presence of dermal armour on these two extraordinary South African Triassic creatures, half-reptile, half-amphibian, respectively named *Pariasaurus* and *Propappus*, the former of which is well known to the public by the huge skeleton exhibited in the fossil reptile gallery in the Natural History Museum at South Kensington. From this it appears that while in *Pariasaurus* the dermal armour is restricted to some three longitudinal rows of ossicles in the neighbourhood of the spines of the vertebræ, *Propappus* appears to have been provided with a complete shield or carapace of such bony plates or ossicles. Further evidence of the distinctness of the two genera is afforded by the fact that *Propappus* occurs on a horizon about 1,000 feet higher than the one yielding the remains of *Pariasaurus*.

ZOKORS.—I dare say that most of my readers do not know what a zokor is, and my friend Mr. Pycraft makes no mention of these creatures in his article on burrowing animals in the April number of "KNOWLEDGE," thereby missing the opportunity of alluding to an extremely interesting instance of resemblance between very different types due to adaptation to similar conditions. Zokors, which

inhabit Central and North-Eastern Asia, are members of the mouse tribe which lead a burrowing life, and although nearly allied to the lemmings, are almost identical in appearance with the mole-rat, to which a paragraph is devoted in the article just quoted. Both genera have the same curious flattening of the head and rounding of the muzzle, which give to the mole-rat its remarkable physiognomy, and in both the eyes are rudimentary and the external ears wanting. The resemblance is, in fact, so close that when engaged the other day in putting out a zokor for exhibition in the British Museum, I had a misgiving I had got hold of a mole-rat by mistake. Indeed, the likeness between a zokor and a mole-rat, if we except the more powerful front claws of the former, is much greater than that between a swift and a swallow. Till recently zokors were generally known to zoologists by the name of *Siphneus*, but it is now the fashion to replace that term by *Myotalpa*. It may be added that if the readers of the article already mentioned pay a visit to the Natural History branch of the British Museum to inspect some of the animals therein referred to, when they see the Chinese hairy bamboo-rat (*Rhizomys vestitus*) they will scarcely be inclined to endorse the statement that the Sumatran species is the largest representative of the genus.

THE WHITE ORYX.—Great interest attaches to the publication by the University of Lyons of the results of a long series of investigations with regard to the animals mummified and painted by the ancient Egyptians. Among the animals identified is the well-known white oryx, now to be found, on this side of Africa only in the Sudan, although in the time of the Pharaohs it seems to have been quite common in the Delta. The most curious result of this investigation is that *ma-hez*, the ancient Egyptian name of this animal, and signifying the white animal of the desert, appears to be the same word as *beisa*, the native name of the beisa oryx of East Africa.

THE FAUNA OF AUSTRALIA.—It is not often that one can catch the late Director of the Natural History Departments of the British Museum tripping, but in a most interesting article on the Tasmanian wolf in the *Daily Telegraph* of April 10 he has made a serious blunder. He there states that Australia and the neighbouring large islands, until man arrived there, were not inhabited by any of the groups of mammals except the cloacalia (the echidna and the duck-bill, or ornithorhynchus) and the marsupials. Now, to say nothing of the flying-foxes and other bats, Australia is the home of several altogether peculiar types of the mouse family, such as the genus *Mastacomys*, the numerous kinds of jerboa-rats, formerly included in the genus *Conilurus*, or *Hapalotis*, but now split up into several generic groups, and the remarkable orange-bellied water rat (*Hydromys*), while an allied species from Queensland represents another peculiar Australasian genus, *Xeromys*. If the learned professor means that all these peculiar types were introduced by the Australian natives, it would be interesting to know from where they came, and how it happened that they were exterminated in the land whence they were brought. If among "the neighbouring large islands" Sir Ray Lankester includes New Guinea, his case is worse, for there are still more Papuan mammals other than marsupials and egg-layers. It appears, however, that our author has made one of those inadvertent mistakes to which we are all—even the least of us—occasionally liable.

PAPERS READ.—At the meeting of the Zoological Society, held on March 16, Dr. A. E. Shipley submitted reports on grouse-disease, for the investigation of which a Committee was appointed some time ago; Mr. Pycraft described the fossil remains of a perching-bird from Pliocene strata near Leghorn, which he believed to indicate a pipit near akin to *Anthus bertheloti*; and Messrs. Thomas and Wroughton discussed a collection of mammals from Java, among which four were described as new. At the following meeting, April 6, Miss M. Roberts described a parasite causing a fatal disease in sea-trout; Mr. C. T. Regan discussed the fishes collected by Dr. Andrews at Christmas Island; Mr. Pocock described as new a ratel, or honey-badger, from Sierra Leone; while Mr. Druce furnished a communication on butterflies of the family *Hesperiidæ* from West Africa.

REVIEWS OF BOOKS.

ASTRONOMY.

Conference Astrophotographique Internationale de Juillit, 1900. Circulaire No. 12 (Paris. Gauthier-Villers; 1907. III. + 14 + A 129 + B 152).—This, the twelfth, and possibly the last, "Eros" circular reports that direct observations of Eros and 671 reference stars have been made in large numbers, those of Eros, 3,752 in Right Ascension, and 2,890 in Declination, and of the stars 19,200 and 16,198 respectively. The photographic observations, on 1,443 plates, include 16,201 of the reference stars, and 1,310 of Eros, besides many of comparison stars. The circular contains the corrected ephemeris for the 1900 opposition of Eros, direct observations from Teramo, Paris, Pulkova, Christiania, and Nice, and photographic observations from Helsingfors, Greenwich, Cambridge, Oxford, Pulkova, Upsala, and Minneapolis. The delay in the issue of this circular is partly due to the fact that the Paris measuring bureau was responsible for dealing with all the plates from Upsala, and part of those from Minneapolis. There are two pages of errata relating to the Toulouse observations published in the eleventh circular.

Observatoire Royal de Belgique; Annuaire Astronomique pour, 1908 (Brussels; 316 and 272 with plates).—This issue of the Belgian "Annuaire" contains some important features in addition to the regular almanac and astronomical tables, which call for no special comment. There is an excellent biographical notice of the late M. Folie and his works. We find also a description of the new Cooke 15-inch equatorial, by E. Merlin, a monograph on the International Astrographic Chart, with special reference to the share taken in it by the Belgian Royal Observatory, by Arthur Smedts, and a well-illustrated article on the progress of astronomical photography, by P. Stroobant. But the most important appendix consists of the first two books of a new Primer of Navigation by Artillery-Lieutenant P. Vanderplasse, the remainder of which is held over for the next annual issue. The object of the work is concisely explained. For reasons easily understood the British Admiralty charts and tables are almost exclusively employed by Belgians, many of whom serve in British ships, owing to the smallness of the Belgian mercantile marine. But they consider the British mercantile officer too haphazard and "rule-of-thumb" in his practical navigation, so, in order to approximate to the thoroughness of the German and French navigators, the Belgian officers are provided with this text-book to render them intelligently competent to make use of the British tables. Whether this idea of the practice obtaining in the British Mercantile Marine has any justification does not, of course, concern the reviewer. The two books (out of a total of six) now given are on chronometers and on the sextant and altitude corrections, and appear to be quite comprehensive.

ARCHÆOLOGY.

Earthwork of England, by A. Hadrian Allcroft, M.A. (Macmillan and Co.; illustrated with plans, sections, etc.; 697 pp.; 18s. net).—This volume constitutes a compendious history of earthworks scattered about the country, including those of prehistoric times, as well as those of Roman, Saxon, Danish, Norman, or of mediæval age. The author's object has been to stimulate a more general interest in the subject by pointing out the abundance of the material which lies to hand, and by suggesting the variety and many-sided interest in the subject. He demonstrates where further research is desirable, and usefully points out the more obvious pitfalls which lie in the path of the inexperienced. In his book the author has endeavoured to place in convenient form the material which is more or less buried in various publications and transactions, much of which is inaccessible to the general reader, and the result is what he modestly terms an elementary text-book of nearly 700 pages. The book contains no less than 225 sections of camps, etc., and maps, and so thorough and complete is the work that to enumerate all that is attempted would be to give a mere catalogue. We find chapters on contour forts, promontory forts, plateau forts, the primitive homestead, dew-ponds, Roman camps and stations, Saxon and Danish earthworks, Norman

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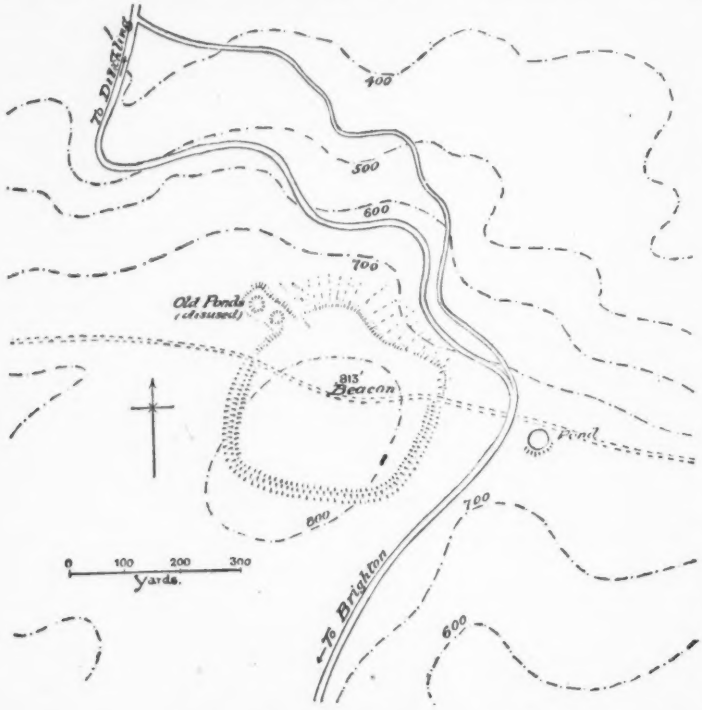
castles, dykes and ditches, miscellaneous earthworks, the South Downs, Dolebury. "With the earlier part of the Stone Age (Palæolithic), earthworks," the author states, "have nothing to do; they belong to the succeeding periods, the Neolithic, the Bronze, and the Iron Ages, and the historical period thereafter." Here is a starting-point, one fact amongst so much that is problematical. The fascination of the subject lies in its mystery. The cocksure archæologist is one to be avoided. One who weighs and sifts his evidence, and then makes a tentative conclusion, is a safe man to follow. Mr. Allcroft is one of the latter, although even he is, perhaps, a trifle scornful over the mistakes of others. But he has done a thoroughly good piece of work, and one which will stimulate. He reminds us of the thousands of earthworks of various kinds to be found in England, and yet those about which anything is really known are very few, whilst about none is everything known. There is yet a wide field for exploration, or, as Mr. Allcroft remarks, "well nigh the entire field lies open to all who care to peg out a claim." In the last three chapters the author has described the South Downs, in telling language, as the last



approach to unspoilt Nature that is easily reached from the Metropolis, and Dolebury, upon the Mendips, by reason of its contrast to the last-mentioned. Many will turn to the description of the South Downs on first handling the book, and the author is seen at his best therein. One gets in touch with him and the spirit which animates him through these latter chapters, and as his companion through the rest of the book one gets to understand him better by reason of the closer contact with Nature to which he has introduced us on the South Downs. With the exceptions of the camps at Edburton and Burpham, those on the South Downs "are all unmistakably British, that is, of an age preceding the Roman occupation, though some may be earlier and some later than others. The fact illustrates the general rule that the handiwork of Roman, Saxon, Dane, and Norman belongs usually to the lower levels. To all seeming the Downs were thickly peopled before the Roman time, but lost their population at that date. It has never returned to them; one can be more lonely to-day on any one of their broad, smooth uplands than anywhere else in South-Eastern England." The illustration, for the use of which we are indebted to the publishers, shows a plan of the earthworks at Ditchling Beacon. These are at the highest part of the Downs, where an altitude of 813 feet is reached. Along the brow of the hill there are no artificial defences, as not being there required, owing to the rapid fall of the ground. The two disused ponds on the west are regarded by the author as of no great antiquity, and in regard to the camp he remarks that "your dreams now should be of times and peoples yet earlier than the Roman, of taller warriors clad in skins and armed with stone, and of others harnessed in bronze, or helmeted with the horned casque of the iron time."

BIOGRAPHY.

The Life of Philibert Commerson, by the late Capt. S. Pasfield Oliver, R.A., edited by G. F. Scott Elliot, F.L.S., F.R.G.S. (John Murray; 10s. 6d. net).—To the majority of people, even including scientists, the name of Commerson conveys no meaning, nevertheless a perusal of the charming volume under consideration will reveal the fact that Philibert Commerson has just claims to rank with the foremost as a scientific pioneer and traveller. Born in the Pays des Dombes, near Lyons, in 1727, Commerson's love for Nature showed itself at a very early age, being an enthusiastic and untiring collector and observer of both plants and animals. Notwithstanding many rebuffs and disappointments, sufficient to extinguish the love for Nature in a less enthusiastic man, Commerson continued his studies, and completed "A History of the Fishes of the Mediterranean," at the suggestion of Linnæus, which, however, was not published. In 1776 he accepted the post of naturalist to the exploring expedition under de Bougainville, which gave him the opportunity he had longed for, and after his signature to his will, prepared previous to his departure, styled himself, "Botanist-Naturalist to the King." During the voyage round the world, Commerson amassed an enormous mass of material, more especially of a botanical nature, the great bulk of which was either lost, or squandered piecemeal. As the voyage was approaching the end Commerson elected to remain at Mauritius, and became official botanist to that colony, afterwards passing on to Madagascar, where many of his most important discoveries were made. From Madagascar he returned to Mauritius, where, broken in health and deprived of his post by intrigue, he died at the age of forty-six. Commerson considered that he knew at least some twenty-five thousand species of plants, and it is estimated that he discovered some three thousand new species and sixty new genera of plants. It is impossible to estimate the indebtedness the world of science owes to the undaunted courage and perseverance of this pioneer; much, however, has been achieved in this direction by the combined efforts of author and editor, who have rescued from oblivion, and presented in a fascinating manner, not only the result of pioneer work accomplished under the difficulties necessarily attendant on travel in the seventeenth century, but also in portraying the nature and influence exercised by a master mind.

BOTANY.

Botany, by J. Reynolds Green, Sc.D., F.R.S.; Dent's Scientific Primers (Dent and Co.; 1s. net).—The author, an acknowledged authority on matters botanical, commences his preface as follows: "In writing this little introduction to the study of a plant I have endeavoured especially to present it to the reader as a living organism." This endeavour has been consistently and successfully carried out. Throughout the book every structure described is correlated with its use or function to the plant in general, a system much preferable to the usual method of separating structure from function. After a general idea of the structure and function of plants has been acquired, the student is introduced to the "Evolution of the forms of Plants," taking Algæ as examples. This is followed by a chapter

on the evolution of the land plant, traced through mosses and ferns. The illustrations are excellent, and it may be stated without fear of contradiction that the present is the best shilling book on botany extant.

CHEMISTRY.

The Nature of Enzyme Action, by W. M. Bayliss (London: Longmans, Green and Co., 1908; pp. ix. and 90; 3s. net).—Some ten years ago it was shown by Dr. E. Buchner that the process of alcoholic fermentation was brought about by a specific ferment or enzyme secreted by the yeast-cell; and that when the cells were ground up with quartz and expressed under great pressure, the resulting clear filtrate was still capable of transforming sugar into alcohol. With this discovery the old division between chemical changes of this kind brought about by living cells and those caused by non-living enzymes was broken down, and it is not improbable that most vital phenomena may eventually be found to be manifestations of enzymic energy. So much work has been done upon the properties of this remarkable class of substances, the chemical nature of which is still unknown, that the subject now has a literature of its own. The present monograph, though written by a foremost worker in this field, must be regarded mainly as a general survey, and it does not attempt to deal with the characteristics of individual enzymes. It is clearly and concisely written, but the lack of space tends to make it too abstruse, especially for the general reader. There is a bibliography of the works quoted in the text, but the book would have gained in value for the student had this been more complete. Thus we fail to notice any reference to many important treatises, including Dr. Oppenheimer's masterly book, an English edition of which appeared three or four years ago. Dr. Bayliss states in his preface that the monograph is based upon his lectures, and, in fact, it has the merits and defects of a good lecture. To those already acquainted with the subject it will bring fresh light; other readers will find it advisable to study it as a supplement to a text-book.

MICROSCOPY.

A Compendium of Food-Microscopy, by Edwy Godwin Clayton, F.C.S., F.I.C., etc. (London: Baillière, Tindall and Cox, 1909; pp. xxxix. and 431, with 282 illustrations; demy 8vo. cl., 10s. 6d. net).—The services rendered by the late Dr. A. H. Hassall to the cause of public health, more especially in reference to the control of the quality of the food and drink of the population at large which now comes under the notice of a highly-trained body of public analysts, can scarcely be overestimated. It is difficult to realise that it is thirty-two years since "Food: Its Adulterations and the Methods for Their Detection" was first published, and Mr. E. G. Clayton, in preparing a new edition, revised according to modern requirements, of the purely microscopical portion of this classic book, under the title of "A Compendium of Food-Microscopy," has incorporated with it a brief notice of the orginal author and of his life's work. The careful drawings themselves deserve reproduction, and we are at one with Mr. Clayton in his preference for such drawings over the majority of published photo-micrographs. The text is clear and lucid, and not overloaded with unnecessary technical description, but is mainly descriptive of and an accompaniment to the plates, so that the book is largely an atlas, rather than a text-book, but an atlas of practical and proved utility. The pages dealing with various starches, and the adulterations of flours and arrowroots, are particularly well done, and an interesting addition is made concerning certain fashionable crazes of the day respecting proprietary wheaten foods, but the adulteration of tea, coffee, sugar, preserves, condiments, tobacco, etc., is dealt with, nor are vegetable and animal parasites neglected. The many plates illustrating the "impurities" of water, however, remind one more of a book on pond-life than of a serious work on analysis, and the elaborate schemes of classification of microscopic fauna and flora on pages 350 to 352 and 355 to 357, with their careful tabulation of the genera of infusoria, rotifers, diatomaceæ, etc., strengthen the impression, so that it is with relief that we learn from the text that, though "the numerous organisms shown were present in the unfiltered, or very imperfectly filtered, Thames and other water supplied to London in 1850-55," yet such conditions are "now, fortunately, in the historic past." The writer has observed few errors in the book, but amongst these might be mentioned a manifest mistake on page xxxix. as to the magnification of an inch objective with an A eye-piece, whilst on page 17 the statement that the grains of oat starch do not exhibit the usual crosses when viewed with polarized light needs modification. The book contains a useful bibliography, and will be found of interest to many microscopists other than public analysts. F. S. S.

ZOOLOGY.

A Treatise on Zoology, edited by Sir Ray Lankester, K.C.B., Part I., fascicle 1, Introduction and Protozoa, by various authors; Part VII., fascicle 3, Crustacea, by Dr. T. Calman (London: A. and C. Black, 1909).—We are delighted to welcome two more volumes of this invaluable work, which for the scientific worker in zoology is far ahead of anything of its kind hitherto published in this country, and will doubtless long remain so. In the introduction the learned editor himself gives a most lucid dissertation on the limitations of zoology, that is to say, the distinction between animals and plants, a subject on which it is safe to say many of us have more or less hazy ideas. He then goes on to point out the features by which the Protozoa are separated from the Metazoa—or, in other words, from the rest of the animal kingdom; and concludes by mentioning the distinction between the various classes of the Protozoa. For the description of these classes no less than six authors are severally responsible, namely, Professor Hickson, Mr. Lister, Drs. Gamble, Willey, and Woodcock, and the late Professor Weldon. Such names are a sufficient guarantee for the excellence of the work, and it must suffice to add that the editor makes a statement to the effect that this volume gives a more (*sic*) complete account of the Protozoa than any work of a like nature, special attention being directed to those groups which have recently lept into importance since they were discovered to be the disseminators of various parasitic diseases. In selecting Dr. Calman, of the British Museum, to undertake the description of the Crustacea, the editor has once more displayed his well-known faculty for putting the right man in the right place. No one, in fact, at least in this country, has a fuller knowledge of the Crustacea than Dr. Calman, and the student has now before him a full and up-to-date account of a very interesting and at the same time a very difficult group. Unfortunately the index does not appear to have been checked, at least if we may judge by one instance. Happening to have just read a paper on the ostracod *Gigantocypris*, we naturally turned to see what Dr. Calman had to say on the subject. Out of three references in the index, one is incorrect, the genus not being mentioned on page 67. We hope in the near future to have the pleasure of welcoming other volumes of this monumental work.

MISCELLANEOUS.

The Religion of Nature, by E. K. Robinson (London: Hodder and Stoughton, 1906; pp. xii. + 215; 3s. 6d.).—In a supplemental slip, the author begs his critics, if they are unable to read the entire volume, at least to peruse carefully the final chapter, in which he sums up the arguments for his case. Mr. Robinson, we venture to think, need not have taken this trouble, as we feel sure that every thoughtful person into whose hands it may come will read his work carefully and attentively. Apart from the correctness or otherwise of his views, the author is to be congratulated on the fearlessness with which he pushes his opinions, and especially on the outspoken manner in which he declares that man's evolution, in place of having been left to chance, is the direct outcome of a preordained divine plan. Throughout the volume we observe, indeed, a spirit of reverence for the Creator, which is noticeable by its absence in some of the works it has been our province to review in these columns. Mr. Robinson's contention is that self-consciousness is a feature by which man is widely sundered from the brute; and that it is owing to the possession of this faculty that he feels pain (or rather knows that he feels pain) in a manner which lower members of creation cannot rival. That it is a dangerous doctrine in some respects, he himself is fully prepared to confess; although he does not admit that this should be a bar to its publication. Whether he has proved his case—either wholly or in part—we must leave our readers to judge for themselves.

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MICROSCOPY

Conducted by F. SHILLINGTON SCALES, M.A., F.R.M.S.

The Preparation of Microscopical Objects.

(*Continued from page* 158.)

Eosin.—This is a favourite diffuse plasmatic stain, and is largely used for staining ova in embryological work. It is also used as a contrast stain with hæmatoxylin, staining cell structures red, whilst the nuclei are blue; but sections require careful washing before being transferred from one stain to the other, as eosin precipitates hæmatoxylin. Eosin may be dissolved in water or alcohol, say, 0.5 per cent. solution, or even in the clearing agent. It is a specific stain for red blood corpuscles, and for certain of the leucocytes. When used with hæmatoxylin for embryological tissues sections may be stained for 15 minutes to an hour with a strong solution of eosin in 90 per cent. alcohol, washed quickly with alcohol, and then stained for twenty minutes or half an hour with a rather weak solution of hæmatoxylin. A favourite use of eosin is to stain blood films in connection with methylene blue. Jenner's formula is, perhaps, the most useful. Add

Water-soluble eosin (Grübler)	1.25 gram.
Distilled Water	100 c.c.

To an equal quantity of Methylene blue	1 gram.
Distilled Water	100 c.c.

Mix in a basin, and stir well. Allow to stand for 24 hours, filter, wash the precipitate well upon the filter with distilled water, dry it thoroughly, take 0.5 gram of the dried powder and dissolve in 100 c.c. of pure methyl alcohol, and again filter. The solution keeps well. Blood films merely require dipping in this for about three minutes, rinsing in distilled water till pink, drying rapidly high over a flame, and mounting in xylol balsam. The making of blood films is beyond my present purpose, but for those who have never attempted it I may mention that a drop of blood may be obtained with a *clean* needle from the finger or the lobe of the ear, and just touched with a cover-glass. A second cover-glass is then immediately placed upon the drop on the first cover-glass and the two drawn quickly apart so that they slide over each other to make a thin film. The secret is to use absolutely clean cover-glasses, which have been cleansed in bichromate of potassium, and kept in alcohol till required, and to make the thinnest (almost invisible) film possible. Some people use the edge of a cigarette paper for this latter purpose, but a little practice enables one to make excellent films by the former method. The film may be dried in the air, but it is better to fix it with *gentle* heat before staining.

Methylen Blue.—The last important stain that I shall deal with is Methylen blue, which is also one of the coal-tar compounds. It is of much value in making preparations of the nervous system, and gives good results with intra-cellular cement-substance similar to impregnation processes with gold and silver. Its use with eosin in staining blood corpuscles has been already mentioned. It must not be confused with methyl-blue. It is a useful *intra-vitam* stain, and is in this respect convenient for the study of small semi-transparent aquatic forms of life, where it is only necessary to colour the water containing the organisms a light blue and to watch the staining until it is satisfactory, remembering, however, that the organisms readily lose their colour again. Sometimes after reaching a certain point they begin to lose colour as readily as they took it up. For nerve-terminals a one per cent. solution of methylen blue in normal saline solution (NaCl. .6 per cent.) is generally used, the tissue being perfectly fresh, and exposed freely to the air during the staining. The process must be examined every few minutes under a microscope and stopped when the required structures are sufficiently stained. The section must not be allowed to dry, but must, on the other hand, be not thickly covered. The stain is very unstable, however, unless the tissue is immediately transferred to a saturated solution of ammonium picrate and left there for from 6 to 24 hours. The final mounting is done in glycerine, or in equal parts of glycerine and ammonium picrate, in which the tissues may with advantage soak for 24 hours before mounting. For ordinary nuclear staining an ordinary aqueous solution is used, and allowed to stain for 1 to 24 hours, or a solution may be made up as follows:—

Methylen Blue	0.25 gram.
Rectified Spirit	20 c.c.
Distilled Water	80 c.c.

To stain nuclei, sections are stained with the above solution for five minutes, rinsed well in distilled water, differentiated in 90 per cent. alcohol, dehydrated, cleared, and mounted in Canada balsam. The washing in distilled water is important as it fixes the stain better against the decolourising effect of the subsequent treatment with alcohol.

Metallic Stains.—The examples given of various methods would be incomplete were reference not made to a type of stain which has for its principle the deposit of a metallic precipitate in the tissues, either in the cells themselves or between them. Of these nitrate of silver and chloride of gold are the two best known examples. Nitrate of silver, as everyone knows, blackens on exposure to light, and is generally used in a half or one per cent. solution for the staining of intercellular substances such as those between the cells of blood vessels and lymphatics, the cornea of the eye, etc. The tissues must be fresh and thin, and must be carefully washed with distilled water to ensure freedom from chlorides, which form an insoluble substance with silver nitrate. They are then stained for 5 to 30 minutes in the silver nitrate solution, and kept in bright light until they begin to darken, washed again in distilled water, and mounted in a glycerine medium. Gold chloride is used as a specific stain for the cornea, and for certain nerve structures, and the process is very similar, but it must suffice to merely mention it here.

I have now to bring these papers to a close. Limitations of space have prevented my doing in any way justice to the subject, and have yet obliged me to carry them on for a longer time than I had intended when I began them. I have dealt with the preparation and mounting of opaque objects, with mounting media, dehydration, clearing agents, cell-making, section-cutting by hand, by freezing, by imbedding in celloidin and in paraffin, with microtomes, and how to use them, with the making of serial sections, and with the principles of staining. In describing staining methods I have endeavoured to avoid specific applications and to confine myself to *principles* only, feeling that more can be learnt from understanding such general

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principles and then endeavouring to apply them to specific instances than if I were to give a series of isolated methods of individual rather than of general application. There are several excellent text-books on the subject where individual methods of staining can be referred to, and of these the first is Mr. Bolles Lee's "Microtomist's Vade Mecum," to which I have frequently alluded and to which I am indebted for not a few of the statements made in these notes. For botanical sections there is no book better than Strasburger's "Practical Botany."

Royal Microscopical Society.

MARCH 17. E. J. Spitta, Esq., M.R.C.S., Vice-President, in the Chair. A new $\frac{1}{12}$ inch immersion objective, presented to the Society by Mr. Ernest Leitz, was exhibited. Mr. C. Lees Curties exhibited C. Baker's new Model D.P.H. Microscope. Dr. J. W. Evans, LL.B., F.G.S., gave a lecture on "The Optical Examination of a Crystal Section in a Rock Slice," illustraded by a large number of lantern slides and by a projection polariscope. Having described the construction and use of polarising microscopes, Dr. Evans described a systematic method of determining the different crystallographic and optical directions in the section by bringing them in turn parallel to the right and left cross-wire, the direction of vibration in the lower Nicol. Each direction is denoted by the index-reading when it is in this position, and all the particulars are embodied in a sketch representing the position of the section when the index-reading is zero. The interference colours shown by the relative retardation of light vibrating in two directions of "inclination" were shown in the case of crystal plates, mica slips, and quartz wedges. On the addition of a prism the spectra of these colours were obtained, showing them to be due to the presence of dark bands which moved from the violet to the red end in ever-increasing numbers, as the thickness of the crystal increased. The method of calculating the thickness of a crystal plate from the interference colours shown by a known mineral was explained, as was also that of ascertaining the bi-refringence of an unknown mineral from the colours it exhibits, and the thickness of the rock-slice. The application of the Becke method of determining the relation of the refractive index of adjoining minerals, was also explained, as well as the use of immersion liquids in order to obtain the exact refractive index of minerals on the margin of a slice, by determining that of the liquid which has the same refractive index, by means of the Abbe refractometer. Mr. C. F. Rousselet read a paper on *Synchaeta fennica*, sp. n., and on the Resting-egg of S. pectinata," illustrated with specimens and drawings.

Quekett Microscopical Club.

April 2, Mr. C. Lees Curties, F.R.M.S., gave an exhibition of some different illuminants for the microscope. All the stands shown had their new $\frac{1}{12}$ oil immersion and, with one exception, Abbe non-achromatic condensers. *Pleurosigma angulatum* was the object employed. Three stands were illuminated with half-inch paraffin lamps—the first with edge of flame, the second had in addition, the small illuminating lens lately suggested by Mr. E. M. Nelson, and the third showed the advantage of employing a green glass screen. The other stands were lighted by two Nernst electric lamps, and the Barnard form of mercury-vapour lamp.

A paper by E. Heron-Allen, F.L.S., F.R.M.S.; and Arthur Earland, on "A New Species of *Technitella* from the North Sea, with some Observations upon Selective Power as Exercised by certain Species of Arenaceous Foraminifera," was read by Mr. Earland. The new species is *Technitella Thompsoni*, sp. nov., and is fully described and figured in the current (April) issue of the *Journal* of the Quekett Microscopical Club. The test is built up entirely of echinoderm plates. It was at first taken for a specimen of *T. legumen*. The authors gave a very interesting account of the selective power exercised in building their tests by certain arenaceous foraminifera.

Mr. E. F. Law gave a lecture, illustrated with lantern photographs, dealing with "The Relation Between the Microscopic Structure and Properties of Alloys." He also gave a short description of the methods employed in preparing metal sections for microscopical examination.

Combined Embedding in Celloidin and Paraffin.

In the *Zeitschrift für wissenchaftliche Mikroscopie* (XXV., 1908, pp. 29-32), A. Breekner gives details of a rather novel method of combining celloidin and paraffin as embedding media. The material is first fixed and thoroughly dehydrated in absolute alcohol and then transferred to a 2 to 3 per cent. solution of celloidin in ether, or ether and alcohol, where it is kept for a time varying from a few hours to some days, according to its size. It is then transferred to chloroform for 5 to 10 hours, and subsequently passed in order through benzole, a warm mixture of benzole and paraffin, and finally into pure melted paraffin, until thoroughly infiltrated with the latter. The paraffin is then rapidly cooled and cut into suitable blocks in the customary way, after which sections are cut as usual. The sections are affixed to the slide or cover-glass by the water or albumen methods and stained as required, but in undergoing such treatment absolute alcohol must not be used, and the necessary dehydration must be carried out by means of a mixture of three parts of xyol to one of carbolic acid (free from water), or by a mixture of chloroform and absolute alcohol in equal parts.

Notes and Queries.

H. C. (Stafford).—If a quarter-inch objective magnifying 40 diameters is used with a × 6 ocular, the total magnification of 240 will be obtained either when the microscope is looked through visually, or when the image is projected in a camera at a distance of 10 ins. from the eyepiece. This is because the visual distance of most people—the distance at which objects are held from the eye—is 10 ins., and the size of things which we see visually depends on the distance from the eye. If the 6-inch tube is used, the magnification will be only 144, whether looked at visually or projected, but the image must still be projected at 10 ins. from the eyepiece in the camera, for exactly the same reason as above. If you increase the camera extension to 20 ins., you will manifestly double the magnification, *i.e.*, to 480 or 288 diameters respectively. If you increase the extension to 30 inches you will multiply it by 3, and so on. Of course, these measurements will be approximate only. If you want exact measurements you must use a stage micrometer and a rule and project the image of the former.

[Communications and inquries on Microscopical matters should be addressed to F. Shillington Scales, "Jersey," St. Barnabas Road, Cambridge. Correspondents are requested not to send specimens to be named.]

XUM

The Face of the Sky for May.

By W. SHACKLETON, F.R.A.S.

THE SUN.—On the 1st the Sun rises at 4.36 and sets at 7.20; on the 31st he rises at 3.52 and sets at 8.3. Sun-spots and faculæ may usually be seen on the solar disc. The positions of the Sun's axis, equator, and heliographic longitude of the centre of disc are shown in the following table:—

Date.	Axis inclined from N. point.	Centre of Disc S. of Sun's Equator.	Heliographic Longitude of Centre of Disc.
May 1 ..	24° 17′W	4° 3′	67° 53′
,, 6 ..	23° 19′W	3° 32′	1° 47′
,, 11 ..	22° 9′W	2° 59′	295° 41′
,, 16 ..	20° 50′W	2° 25′	229° 33′
,, 21 .	19° 20′W	1° 50′	163° 24′
,, 26 ..	17° 42′W	1° 15′	97° 15′
,, 31 ..	15° 55′W	0° 39′	31° 5′

THE MOON:—

Date.	Phases.	H. M.
May 5..	○ Full Moon	0 8 p.m.
,, 12..	☾ Last Quarter	9 45 p.m.
,, 19..	● New Moon	1 42 p.m.
,, 27..	☽ First Quarter	1 28 a.m.
May 16..	Perigee.	8 30 p.m.
,, 28..	Apogee.	5 24 p.m.

OCCULTATIONS.—The following are the occultations of the brighter stars.

Date.	Star's Name.	Magnitude.	Disappearance.			Reappearance.		
			Mean Time.	Angle from N. point.	Angle from Vertex	Mean Time.	Angle from N. point.	Angle from Vertex
			p. m.			p. m.		
May 22	ω Geminorum	5·3	9 12	114°	74°	10 2	260°	222°
,, 26	*i* Leonis ..	5·7	9 42	65°	28°	10 22	349°	309°
,, 31	κ Virginis ..	4·3	8 44	119°	128°	10 4	306°	301°

THE PLANETS.—Mercury (May 1, R.A. $3^h\ 14^m$; Dec. N. 19° 15′. May 31, R.A. $5^h\ 49^m$; Dec. N. 23° 49′) is an evening star in Taurus, setting at 10.2 p.m. on the 20th, when the planet is at greatest Easterly elongation of 22° 22′. The elongation is a somewhat favourable one, and the planet should readily be discerned low down in the North-West portion of the sky soon after sunset. In the telescope, the planet appears crescent, 0·35 of the disc being illuminated, whilst the apparent diameter is 8″.

Venus (May 1, R.A. $2^h\ 36^m$; Dec. N. 14° 27′. May 31, R.A. $5^h\ 8^m$; Dec. N 23° 17′) is an evening star in Aries and Taurus, but for all practical purposes the planet is out of range, as she sets only about half-an-hour after the Sun.

Mars (May 1, R.A. $21^h\ 9^m$; Dec. S. 18° 4′. May 31, R.A. $22^h\ 25^m$; Dec. S. 12° 36′) is a morning star, situated on the confines of Capricorn and Aquarius. On the 1st the planet rises a 2.7 a.m., and on the 31st at 12.54 a.m. The apparent diameter of the planet is about 9″·5, and its brightness is increasing. The planet is not yet a favourable object for observation, but in about a month's time, systematic observations should be begun in order to prepare for the September opposition.

Jupiter (May 1, R.A. $10^h\ 28^m$; Dec. N. 11° 4′. May 31, R.A. $10^h\ 32^m$; Dec. N. 10° 30′) is the most conspicuous object in the evening sky, and well placed for observation. On the 15th the planet sets at 2 a.m.; on the 1st he is stationary, after which his apparent motion is direct or Easterly, whilst on the 27th he is in quadrature with the Sun. On account of his brightness, the belt markings on the disc and bright satellites, this is the easiest and most interesting planet to observe in small telescopes. The polar flattening is also noticeable since the equatorial diameter is 38″ and the polar diameter 2″·5 smaller. Observing in the early evening of the 18th, satellites I., II., and IV. appear to be clustered near the Eastern limb of the planet, and again on the 26th all four satellites are clustered near the Western limb.

The following table gives the satellite phenomena observable in this country before midnight:—

Date.	Satellite.	Phenomenon.	P.M.'s. H. M.	Date.	Satellite.	Phenomenon.	P.M.'s. H. M.	Date.	Satellite.	Phenomenon.	P.M.'s. H. M.
May.				May.				May.			
1	I.	Tr. E.	9 8	9	I.	Ec. R.	9 18	24	I.	Tr. E.	9 14
	I.	Sh. E.	10 17	15	I.	Tr. I.	10 33		I.	Sh. E.	10 30
4	II.	Tr. I.	9 54		I.	Sh. I.	11 48	27	IV.	Oc. R.	10 14
5	III.	Oc. D.	9 43	16	I.	Ec. R.	11 13	29	II.	Sh. I.	9 23
6	II.	Ec. R.	10 8	19	IV.	Sh. E.	11 38		II.	Tr. E.	9 46
7	I.	Oc. D.	11 20	20	II.	Oc. D.	10 0	30	III.	Tr. I.	11 27
8	I.	Tr. I.	8 40	22	II.	Sh. E.	9 36		I.	Oc. D.	11 31
	I.	Sh. I.	9 53	23	I.	Oc. D.	9 36	31	I.	Sh. I.	10 6
	I.	Tr. E.	10 59		III.	Tr. E.	10 57		I.	Tr. E.	11 9

"Oc. D." denotes the disappearance of the Satellite behind the disc, and "Oc. R." its reappearance; "Tr. I." the ingress of a transit across the disc, and "Tr. E." its egress; "Sh. I." the ingress of a transit of the shadow across the disc, and "Sh. E." its egress; "Ec. D." denotes disappearance of Satellite by Eclipse, and "Ec. R." its reappearance.

Saturn (May 1, R.A. $1^h\ 4^m$; Dec. N. 4° 26′. May 31, R.A. $1^h\ 17^m$; Dec. N. 5° 36′) is a morning star in Pisces, rising about 3 a.m. near the middle of the month.

Uranus (May 16, R.A. $19^h\ 31^m$; Dec. S. 22° 16′) rises about 11.50 p.m. near the middle of the month. The planet is not well placed for observation, as he is situated low down in Sagittarius.

Neptune (May 16, R.A. $7^h\ 5^m$; Dec. N. 21° 54′) is observable in the North-West portion of the evening sky, about 1° North-East of the star ζ Geminorum; on the 15th he sets about 11.30 p.m.

The planet is difficult to identify among the numerous small stars appearing in the same field of view, as it requires a high power (about 300) and good definition to distinguish his disc; he can, however, be detected by his relative motion if observation be made on successive nights.

METEOR SHOWERS:—

The principal shower during May is the *Aquarids*. This may be looked for between May 1 to 6; the radiant being in R.A. $22^h\ 32^m$ Dec. S. 2°, near the star η Aquarii.

TELESCOPIC OBJECTS:—

DOUBLE STARS.—α Libræ, XIV.^{h} 46^m, S. 15° 40′, mags. 3, 6; separation 230″; very wide pair.

σ Coronæ, XVI.^{h} 11^m, N. 34° 8′, mags. 6, 6½; separation 5″·2; binary.

α Herculis, XVII.^{h} 10^m, N. 14° 30′, mags. 2½, 6; separation 5″·0. Very pretty double, with good contrast of colours, the brighter components being orange, the other blue.

δ Herculis, XVII.^{h} 11^m, N. 24° 57′, mags. 3, 8; separation 14″.

CLUSTERS.—M13 (cluster in Hercules) is situated about one-third the distance from η to ζ Herculis, and is just visible to the naked eye. It is a globular cluster, and with a 3 or 4 inch telescope the outlying parts of the cluster can be resolved into a conglomeration of stars.

XUM